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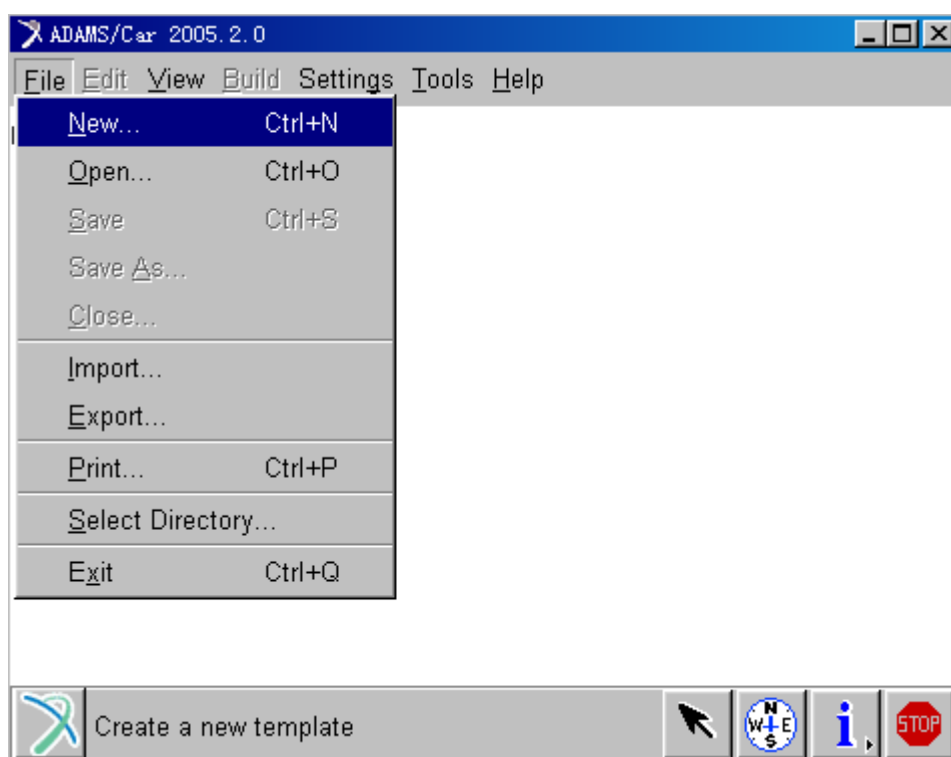
# 《前悬架篇》

## 2 前悬架模板建模

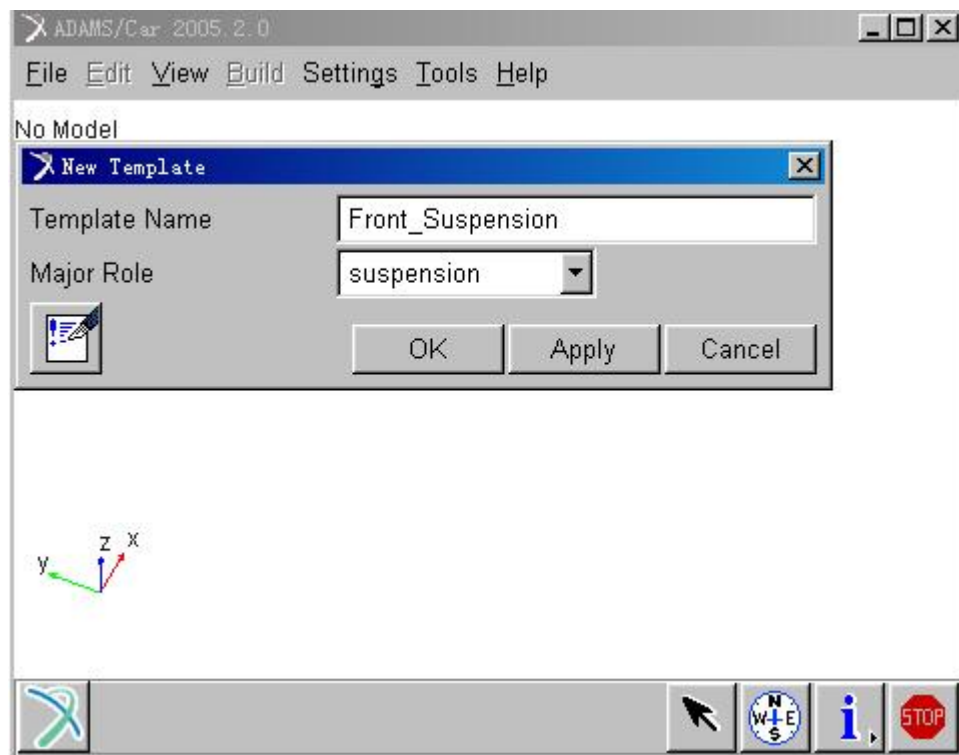
启动 Adams/Car, 进入 Template Builder 模块



点击 File 下拉菜单, 选择 New:



在出现的对话框里 Template Name 一栏输入模板名称 Front\_Suspension, Major Role 选择 suspension



在 ADAMS/Car 里创建模型拓扑结构的三步曲是：

1) 创建硬点 (hard point)。硬点是建模的关键和基础。它定义了构件的空间位置关系。创建硬点只需要输入相应的三坐标值，这些值的来源可以从三维数模上测量，二维 CAD 图，也可以是基于实车测量。

2) 创建部件。在创建好硬点后就可以基于硬点创建部件。这个 part 是一个抽象物体，没有具体形状，为使其更直观要添加几何。在 ADAMS/Car 里 part 的类型有四种：


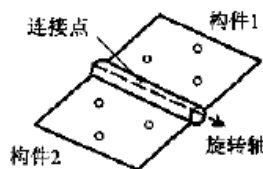

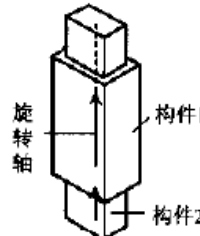

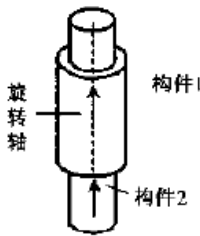



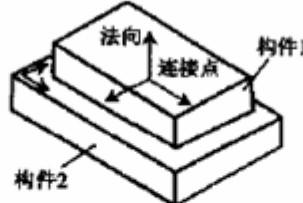

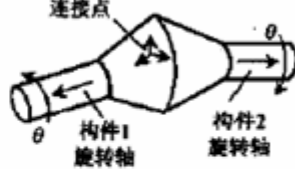

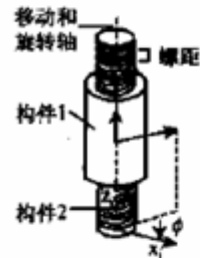

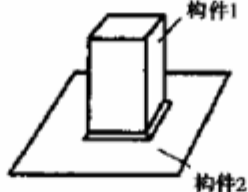



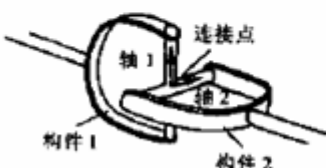

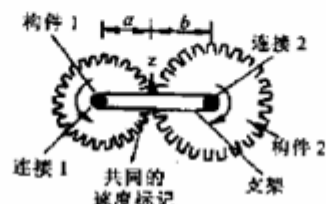
刚体 (rigid part)

柔性体 (flexible part)

假体 (Mount Part)

3) 创建部件间的连接 (运动副)

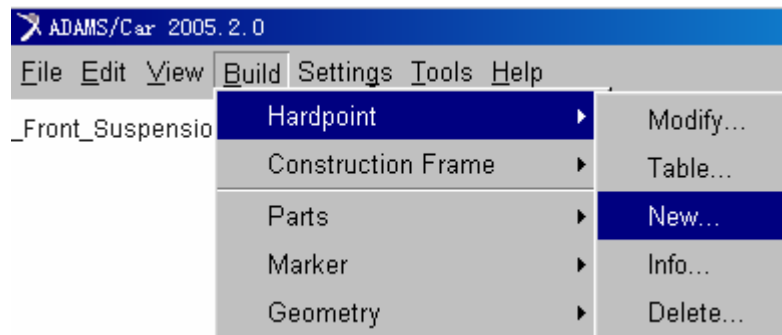
常见的运动副

<p>1. 铰接副 </p>  <p>约束 2 个旋转 3 个移动自由度</p>	<p>2. 棱柱副 </p>  <p>约束 3 个旋转 2 个移动自由度</p>	<p>3. 圆柱副 </p>  <p>约束 3 个旋转 2 个移动自由度</p>
<p>4. 球形副 </p>  <p>约束 3 个移动自由度</p>	<p>5. 平面副 </p>  <p>约束 2 个旋转 1 个移动自由度</p>	<p>6. 恒速副 </p>  <p>约束 1 个旋转 3 个移动自由度</p>
<p>7. 螺旋副 </p>  <p>约束 1 个自由度*</p>	<p>8. 固定副 </p>  <p>约束 3 个旋转 3 个移动自由度</p>	<p>9. 万向副 </p>  <p>约束 1 个旋转 3 个移动自由度</p>
<p>10. 万向副 </p>  <p>约束 1 个旋转 3 个移动自由度</p>	<p>11. 齿轮副 </p> 	

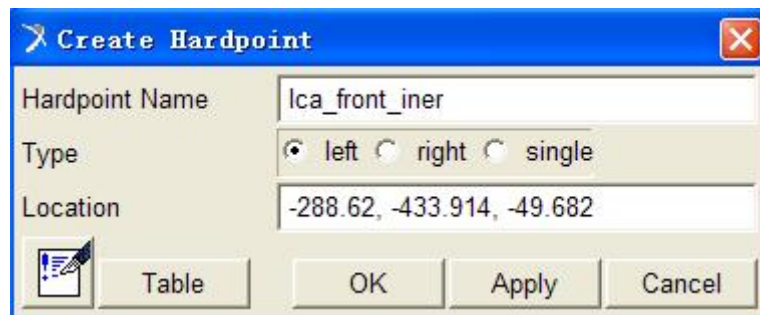
## 2.1 创建下前控制臂

### 2.1.1 创建硬点（下前控制臂内外点）

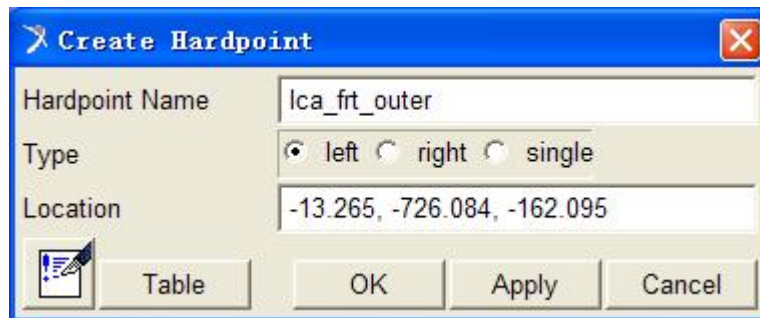
点击 Build 下拉菜单，选择 Hardpoint>New



在出现的对话框里填入以下内容：



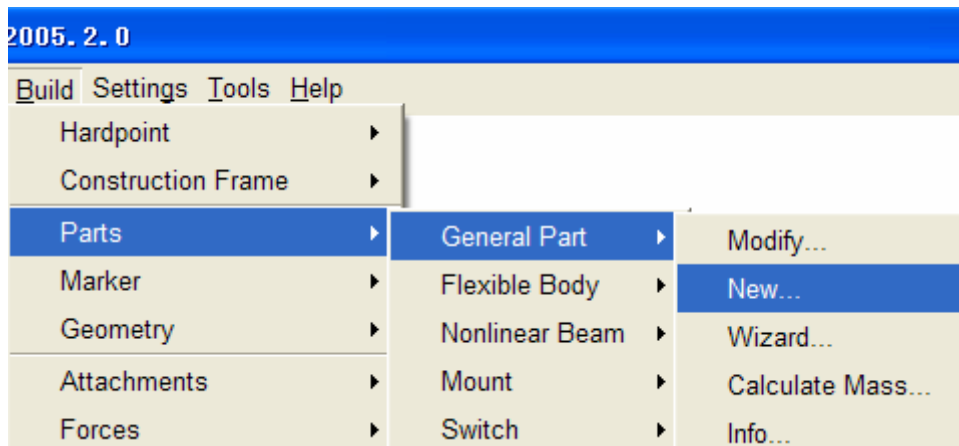
点击 Apply 后创建内点，在当前对话框里继续填入以下内容：



点击 OK，创建下前控制臂外点。

### 2.1.2 创建下前控制臂 part

点击 Build 下拉菜单，选择 Parts>General Part>New

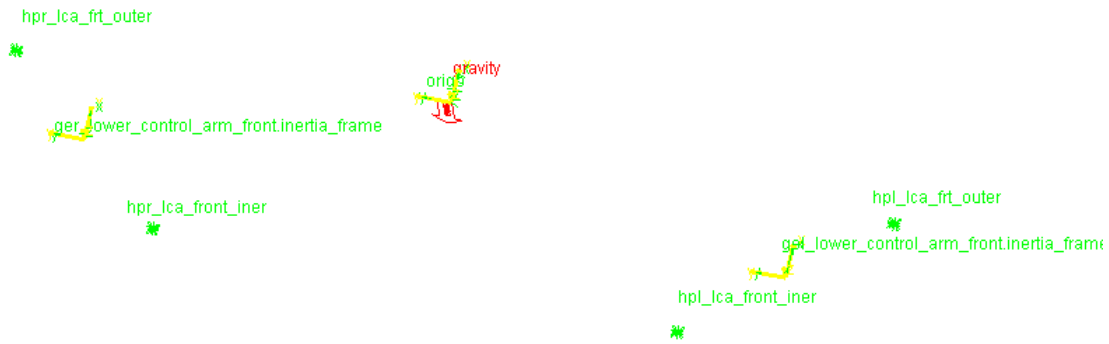


在出现的对话框里填入以下内容：

The 'Create General Part' dialog box contains the following fields and settings:

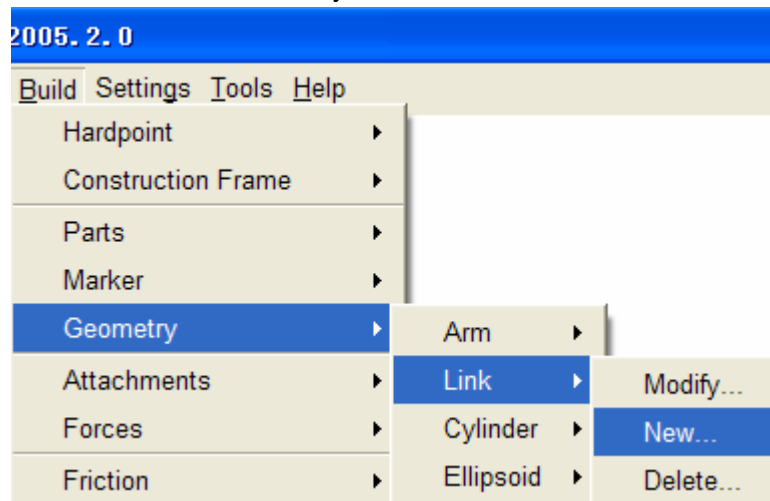
- General Part:** lower\_control\_arm\_front
- Type:** ☒ left ☐ right ☐ single
- Location Dependency:** Centered between coordinates
- Centered between:** Two Coordinates
- Coordinate Reference #1:** \_BMW\_X5\_front\_suspension.ground.hpl\_lca\_front\_iner
- Coordinate Reference #2:** \_BMW\_X5\_front\_suspension.ground.hpl\_lca\_frt\_outer
- Coordinate Reference #3:** (empty)
- Coordinate Reference #4:** (empty)
- Orientation Dependency:** User-entered values
- Orient using:** ☒ Euler Angles ☐ Direction Vectors
- Euler Angles:** 0,0,0
- X Vector:** 1,0,0,0,0,0
- Z Vector:** 0,0,0,0,1,0
- Mass:** 1
- Ixx:** 1
- Iyy:** 1
- Izz:** 1
- Off-Diagonal Terms:** ☐
- CM Location Relative to Part:** (empty field)

点击 OK，至此已创建的如下图所示：

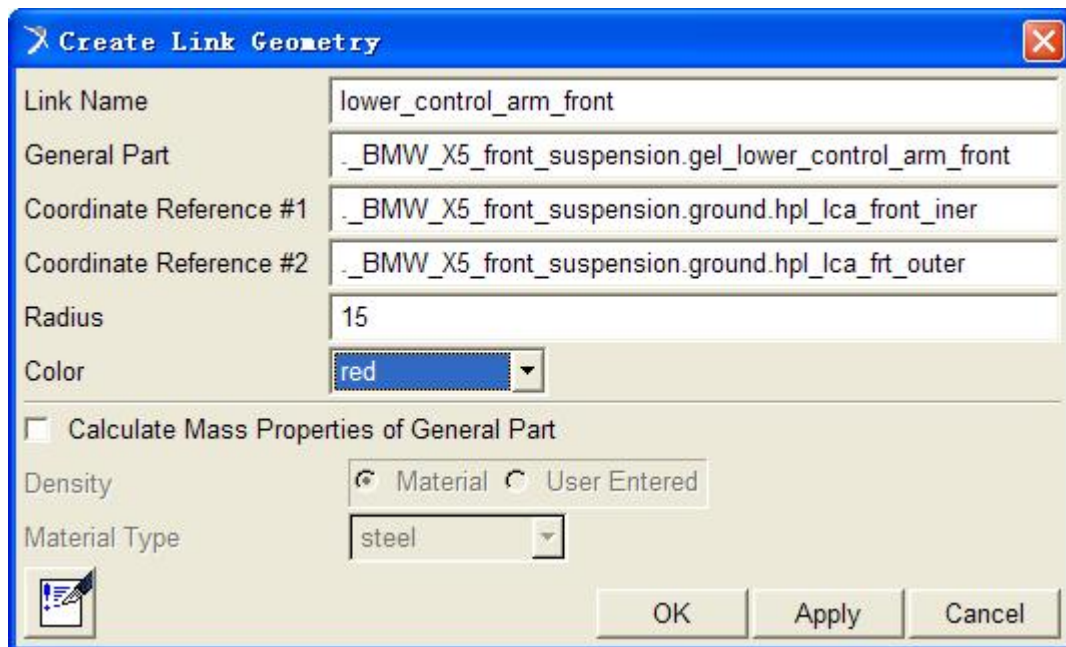


### 2.1.3 创建下前控制臂几何体

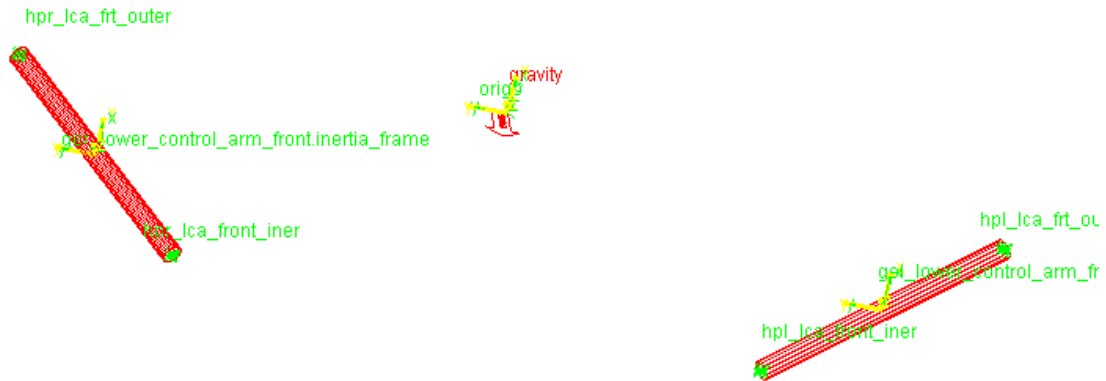
点击 Build 下拉菜单，选择 Geometry>Link>New



在出现的对话框里填入如下内容：



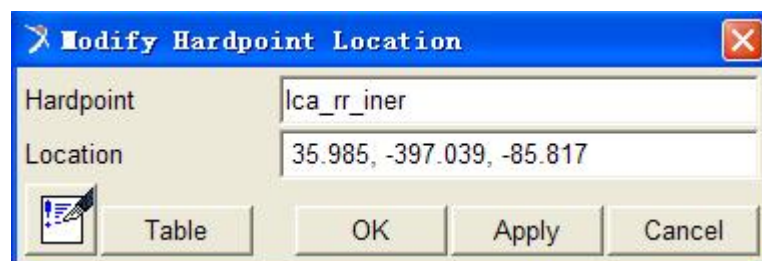
点击 OK，创建的几何体如下图所示：



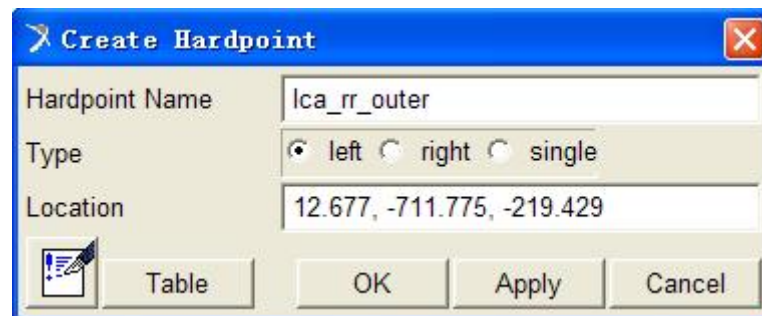
## 2.2 创建下后控制臂

### 2.2.1 创建硬点（下后控制臂内外点）

点击 Build 下拉菜单，选择 Hardpoint>New，在出现的对话框里填入以下内容：



点击 Apply，再输入以下内容：



点击 OK，至此下后控制臂的内外点已经创建，如下图所示：



### 2.2.2 创建下后控制臂 part

点击 Build 下拉菜单，选择 Parts>General Part>New，在出现的对话框里输入以下内容：

**Create General Part**

General Part:

Type: ☒ left ☐ right ☐ single

Location Dependency:

Centered between:

Coordinate Reference #1:

Coordinate Reference #2:

Coordinate Reference #3:

Coordinate Reference #4:

Orientation Dependency:

Coordinate Reference #1:

Coordinate Reference #2:

Axis: ☒ Z ☐ X


Mass:

Ixx:  ☐ Off-Diagonal Terms

Iyy:

Izz:

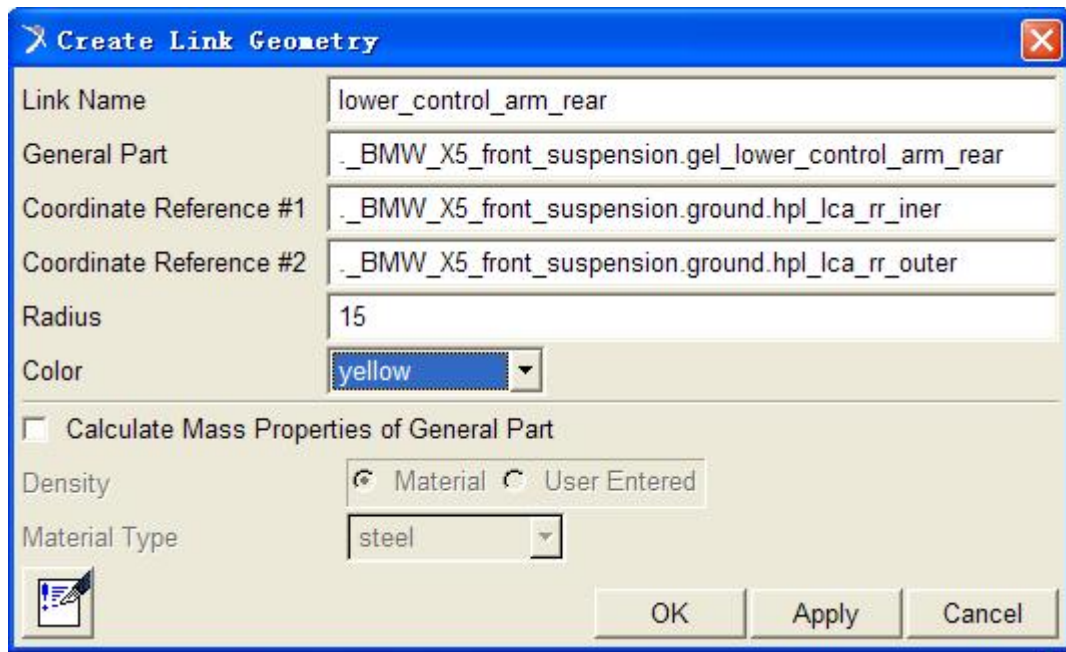
CM Location Relative to Part:



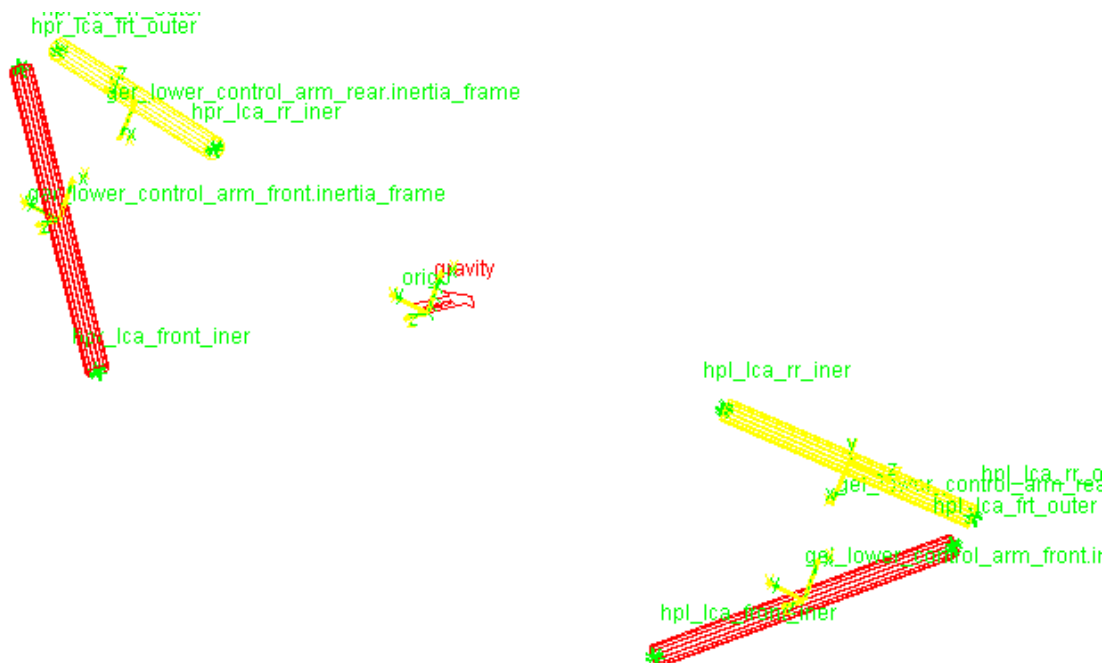
点击 OK。

### 2.2.3 创建下后控制臂几何体

点击 Build 下拉菜单，选择 Geometry>Link>New



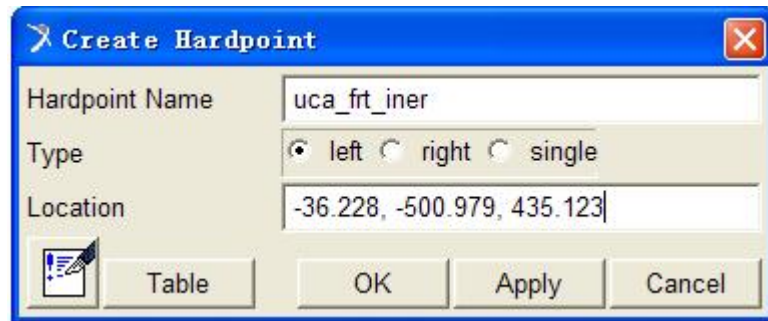
点击 OK 后创建下后控制臂几何体，如下图所示：



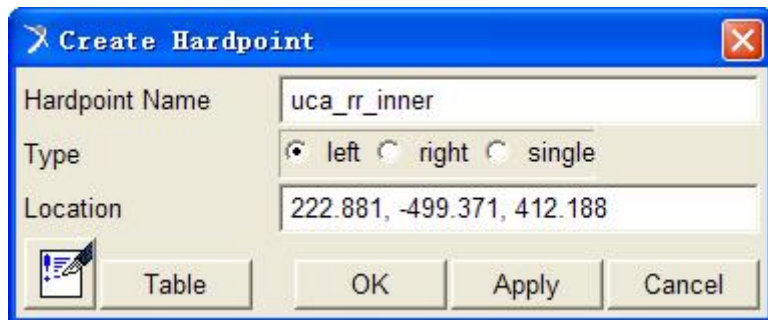
## 2.3 创建上控制臂

### 2.3.1 创建硬点

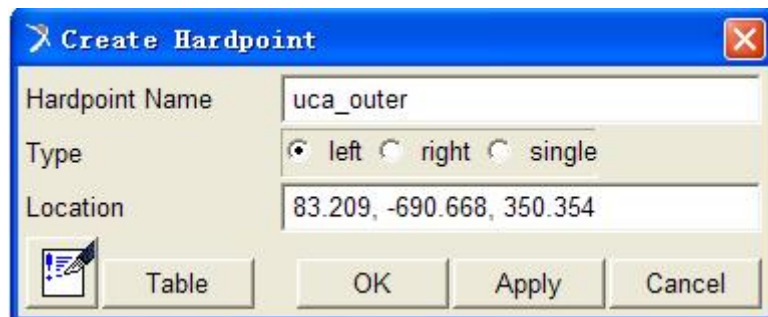
点击 Build 下拉菜单，选择 Hardpoint>New，在出现的对话框里填入以下内容：



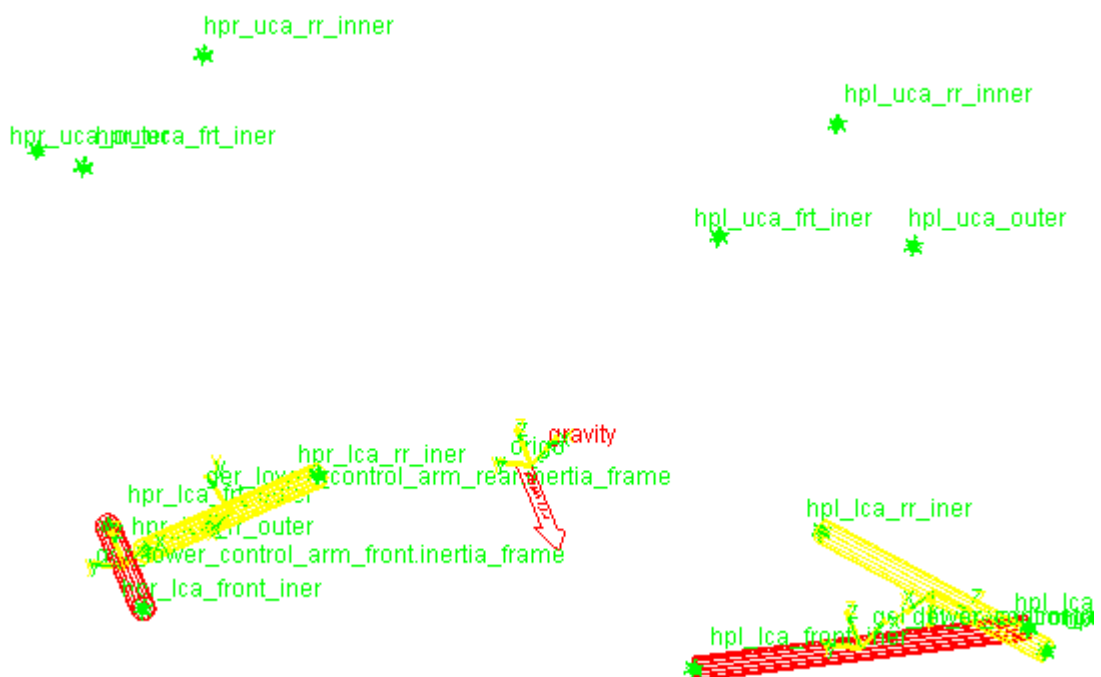
点击 Apply，再输入以下内容：



点击 Apply，再输入以下内容：

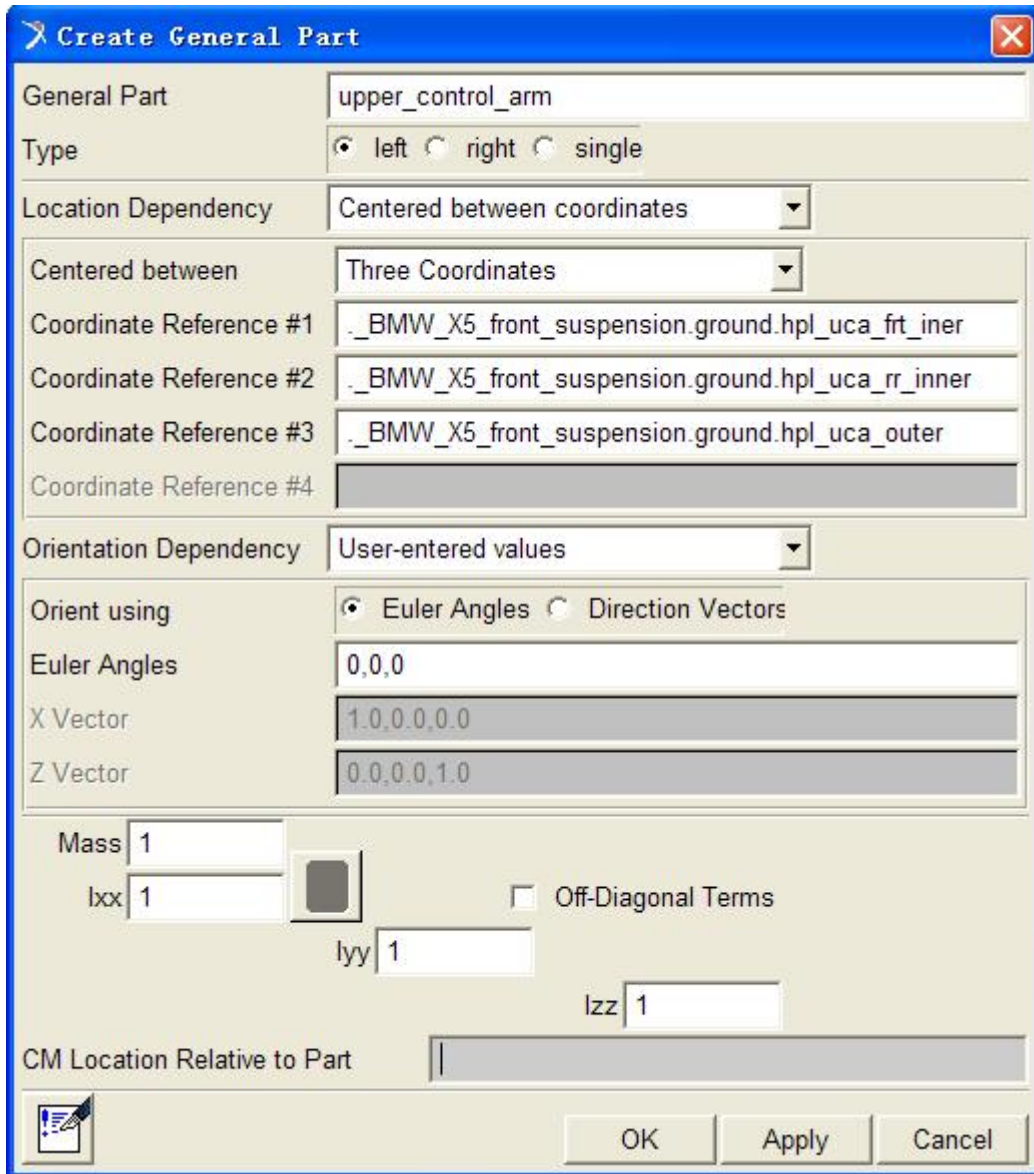


点击 OK，控制臂的三个硬点如下图所示：



### 2.3.2 创建下后控制臂 part

点击 Build 下拉菜单，选择 Parts>General Part>New，在出现的对话框里输入以下内容：



The image shows the 'Create General Part' dialog box in a software application. The dialog has a blue title bar with the text 'Create General Part' and a close button. The main area is divided into several sections with labels and input fields. The 'General Part' section has a text field containing 'upper\_control\_arm'. The 'Type' section has three radio buttons: 'left' (selected), 'right', and 'single'. The 'Location Dependency' section has a dropdown menu set to 'Centered between coordinates'. Below this, the 'Centered between' section has a dropdown menu set to 'Three Coordinates'. The 'Coordinate Reference' section has four text fields: 'Coordinate Reference #1' with '\_BMW\_X5\_front\_suspension.ground.hpl\_uca\_frt\_iner', 'Coordinate Reference #2' with '\_BMW\_X5\_front\_suspension.ground.hpl\_uca\_rr\_inner', 'Coordinate Reference #3' with '\_BMW\_X5\_front\_suspension.ground.hpl\_uca\_outer', and 'Coordinate Reference #4' which is empty. The 'Orientation Dependency' section has a dropdown menu set to 'User-entered values'. The 'Orient using' section has two radio buttons: 'Euler Angles' (selected) and 'Direction Vectors'. The 'Euler Angles' section has a text field with '0,0,0'. The 'X Vector' section has a text field with '1,0,0,0,0,0'. The 'Z Vector' section has a text field with '0,0,0,0,1,0'. The 'Mass' section has a text field with '1'. The 'Inertia' section has three text fields: 'Ixx' with '1', 'Iyy' with '1', and 'Izz' with '1'. There is a checkbox labeled 'Off-Diagonal Terms' which is unchecked. The 'CM Location Relative to Part' section has a text field which is empty. At the bottom, there is a 'Help' icon (a question mark in a circle) and three buttons: 'OK', 'Apply', and 'Cancel'.

General Part	upper_control_arm
Type	<input checked="" type="radio"/> left <input type="radio"/> right <input type="radio"/> single
Location Dependency	Centered between coordinates
Centered between	Three Coordinates
Coordinate Reference #1	_BMW_X5_front_suspension.ground.hpl_uca_frt_iner
Coordinate Reference #2	_BMW_X5_front_suspension.ground.hpl_uca_rr_inner
Coordinate Reference #3	_BMW_X5_front_suspension.ground.hpl_uca_outer
Coordinate Reference #4	
Orientation Dependency	User-entered values
Orient using	<input checked="" type="radio"/> Euler Angles <input type="radio"/> Direction Vectors
Euler Angles	0,0,0
X Vector	1,0,0,0,0,0
Z Vector	0,0,0,0,1,0
Mass	1
Ixx	1
Iyy	1
Izz	1
Off-Diagonal Terms	<input type="checkbox"/>
CM Location Relative to Part	

点击 OK。

### 2.3.3 创建下后控制臂几何体

点击 Build 下拉菜单，选择 Geometry>Link>New

**Create Link Geometry**

Link Name	uca_ft
General Part	._BMW_X5_front_suspension.gel_upper_control_arm
Coordinate Reference #1	._BMW_X5_front_suspension.ground.hpl_uca_ft_iner
Coordinate Reference #2	._BMW_X5_front_suspension.ground.hpl_uca_outer
Radius	15
Color	red
<input type="checkbox"/> Calculate Mass Properties of General Part	
Density	<input checked="" type="radio"/> Material <input type="radio"/> User Entered
Material Type	steel

OK Apply Cancel

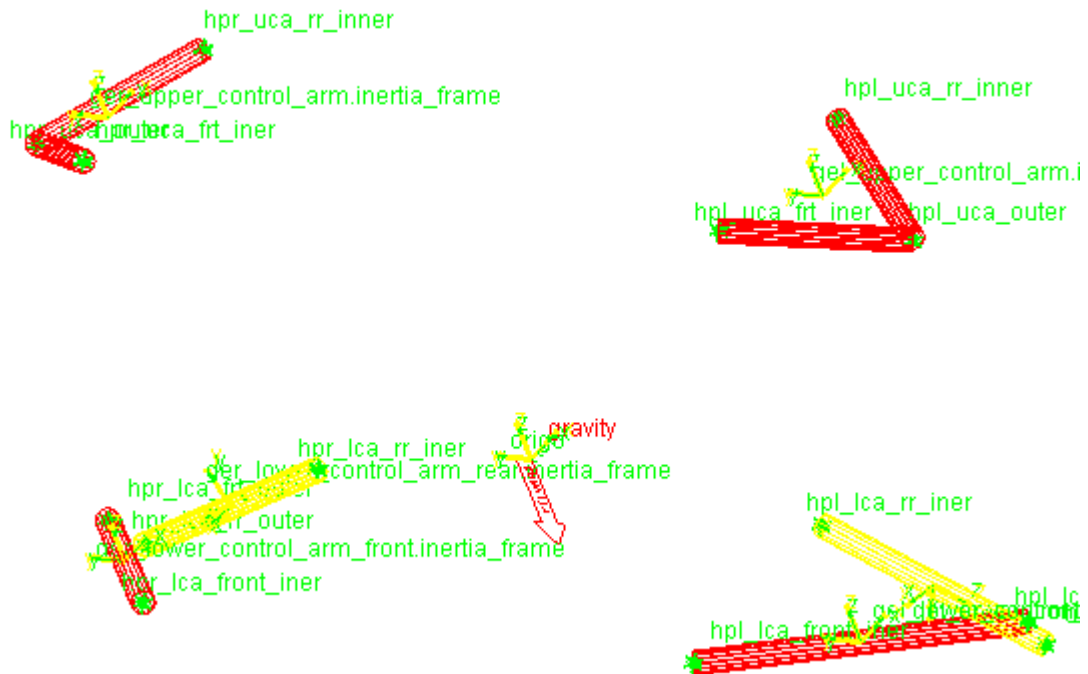
点击 Apply 后，再填入如下内容：

**Create Link Geometry**

Link Name	uca_rr
General Part	._BMW_X5_front_suspension.gel_upper_control_arm
Coordinate Reference #1	._BMW_X5_front_suspension.ground.hpl_uca_rr_inner
Coordinate Reference #2	._BMW_X5_front_suspension.ground.hpl_uca_outer
Radius	15
Color	red
<input type="checkbox"/> Calculate Mass Properties of General Part	
Density	<input checked="" type="radio"/> Material <input type="radio"/> User Entered
Material Type	steel

OK Apply Cancel

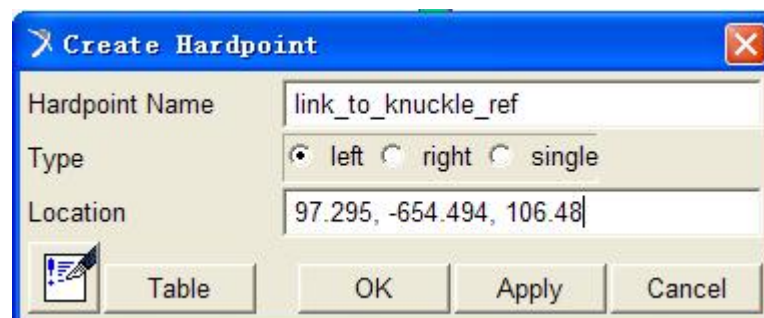
点击 OK 后创建上控制臂几何体，如下图所示：



## 2.4 创建转向节

### 2.4.1 创建硬点

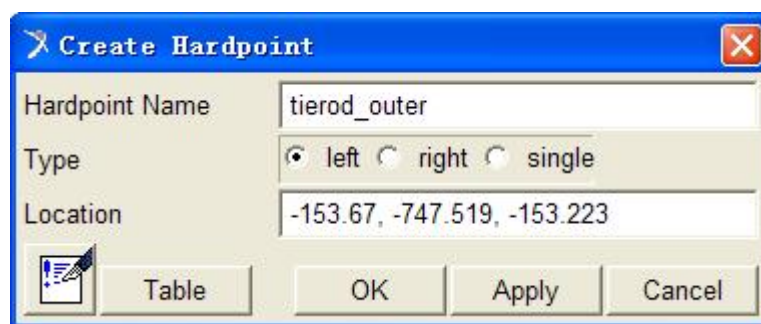
点击 **Build** 下拉菜单，选择 **Hardpoint>New**，填入以下内容



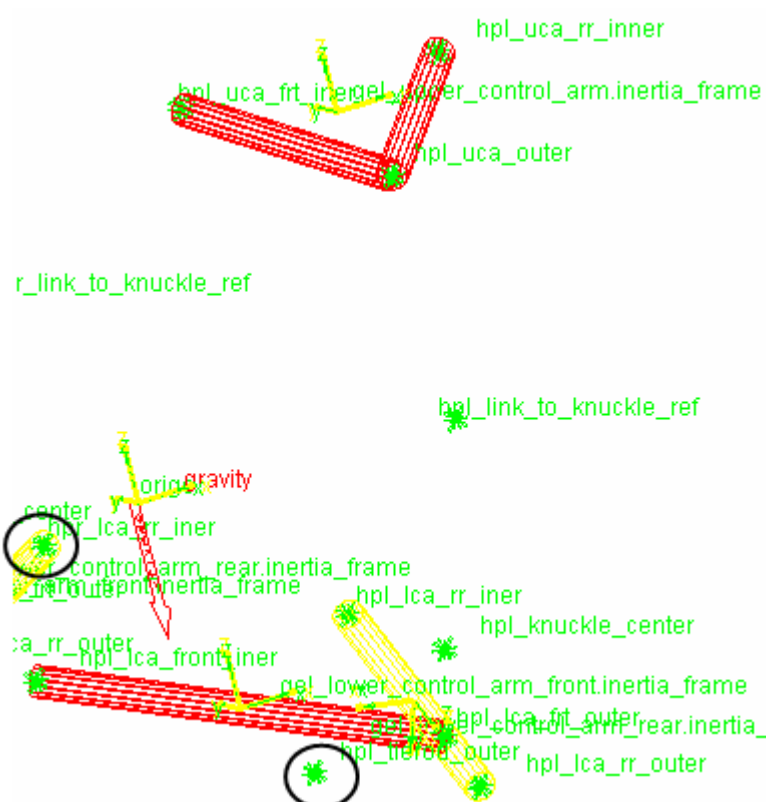
点击 **Apply** 后继续填入以下内容:



点击 Apply, 输入以下内容:



点击 OK。



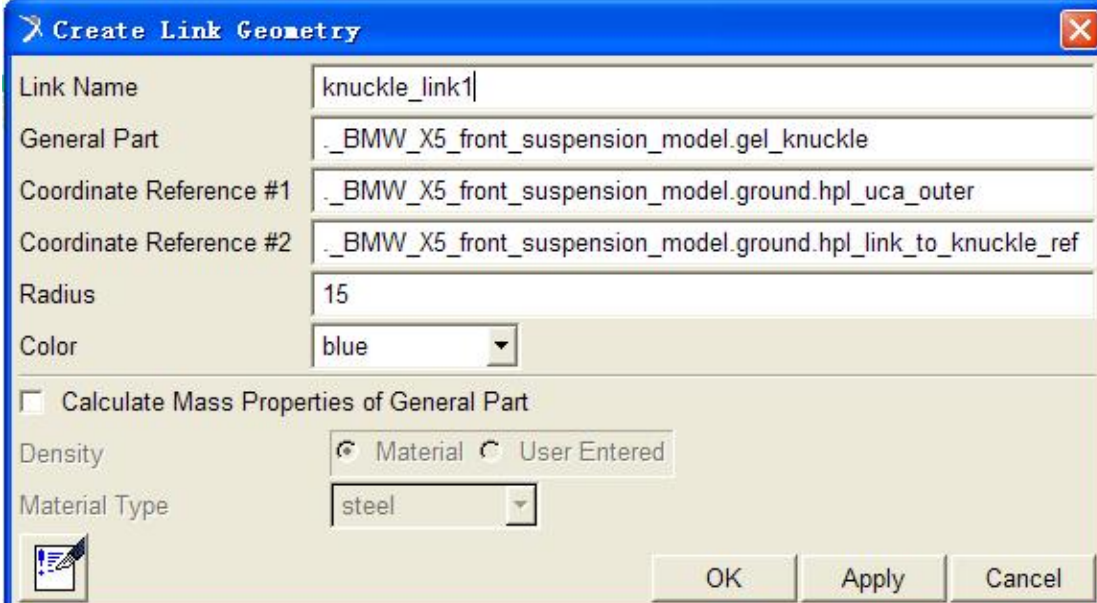
### 2.4.2 创建转向节 part

点击 Build 下拉菜单，选择 Parts>General Part>New，输入以下内容：



### 2.4.3 创建转向节几何体

点击 Build 下拉菜单，选择 Geometry>Link>New

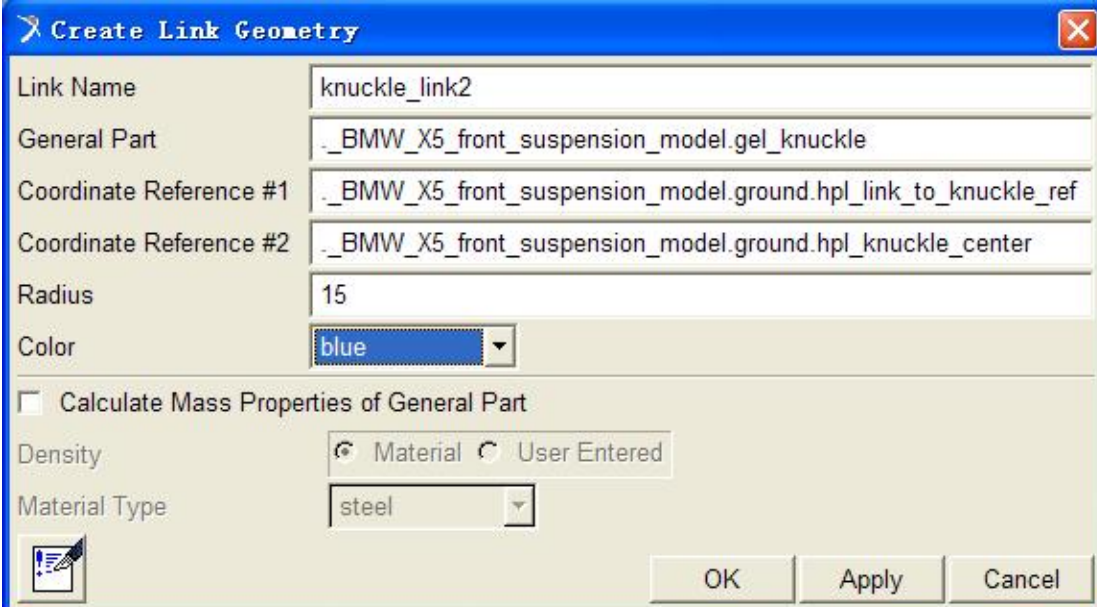


The dialog box titled "Create Link Geometry" contains the following fields and options:

Link Name	knuckle_link1
General Part	._BMW_X5_front_suspension_model.gel_knuckle
Coordinate Reference #1	._BMW_X5_front_suspension_model.ground.hpl_uca_outer
Coordinate Reference #2	._BMW_X5_front_suspension_model.ground.hpl_link_to_knuckle_ref
Radius	15
Color	blue
<input type="checkbox"/> Calculate Mass Properties of General Part	
Density	<input checked="" type="radio"/> Material <input type="radio"/> User Entered
Material Type	steel

Buttons: OK, Apply, Cancel

点击 Apply，输入以下内容：



The dialog box titled "Create Link Geometry" contains the following fields and options:

Link Name	knuckle_link2
General Part	._BMW_X5_front_suspension_model.gel_knuckle
Coordinate Reference #1	._BMW_X5_front_suspension_model.ground.hpl_link_to_knuckle_ref
Coordinate Reference #2	._BMW_X5_front_suspension_model.ground.hpl_knuckle_center
Radius	15
Color	blue
<input type="checkbox"/> Calculate Mass Properties of General Part	
Density	<input checked="" type="radio"/> Material <input type="radio"/> User Entered
Material Type	steel

Buttons: OK, Apply, Cancel

点击 Apply，输入以下内容：

**Create Link Geometry**

Link Name	knuckle_link3
General Part	._BMW_X5_front_suspension_model.gel_knuckle
Coordinate Reference #1	._BMW_X5_front_suspension_model.ground.hpl_knuckle_center
Coordinate Reference #2	._BMW_X5_front_suspension_model.ground.hpl_lca_ft_outer
Radius	15
Color	blue
<input type="checkbox"/> Calculate Mass Properties of General Part	
Density	<input checked="" type="radio"/> Material <input type="radio"/> User Entered
Material Type	steel

OK Apply Cancel

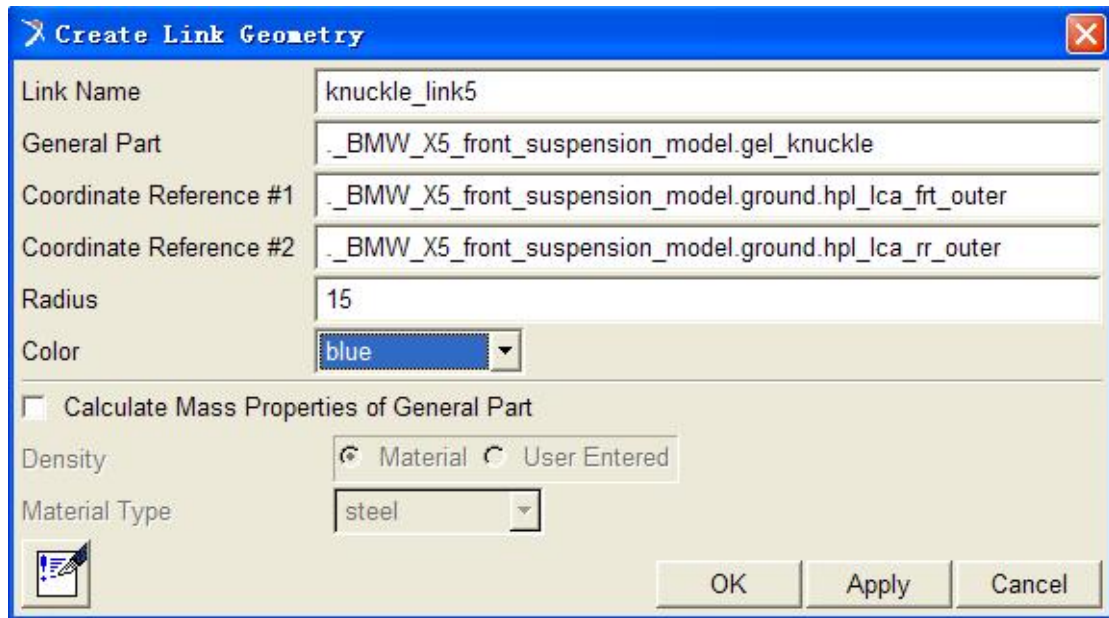
点击 Apply，输入以下内容：

**Create Link Geometry**

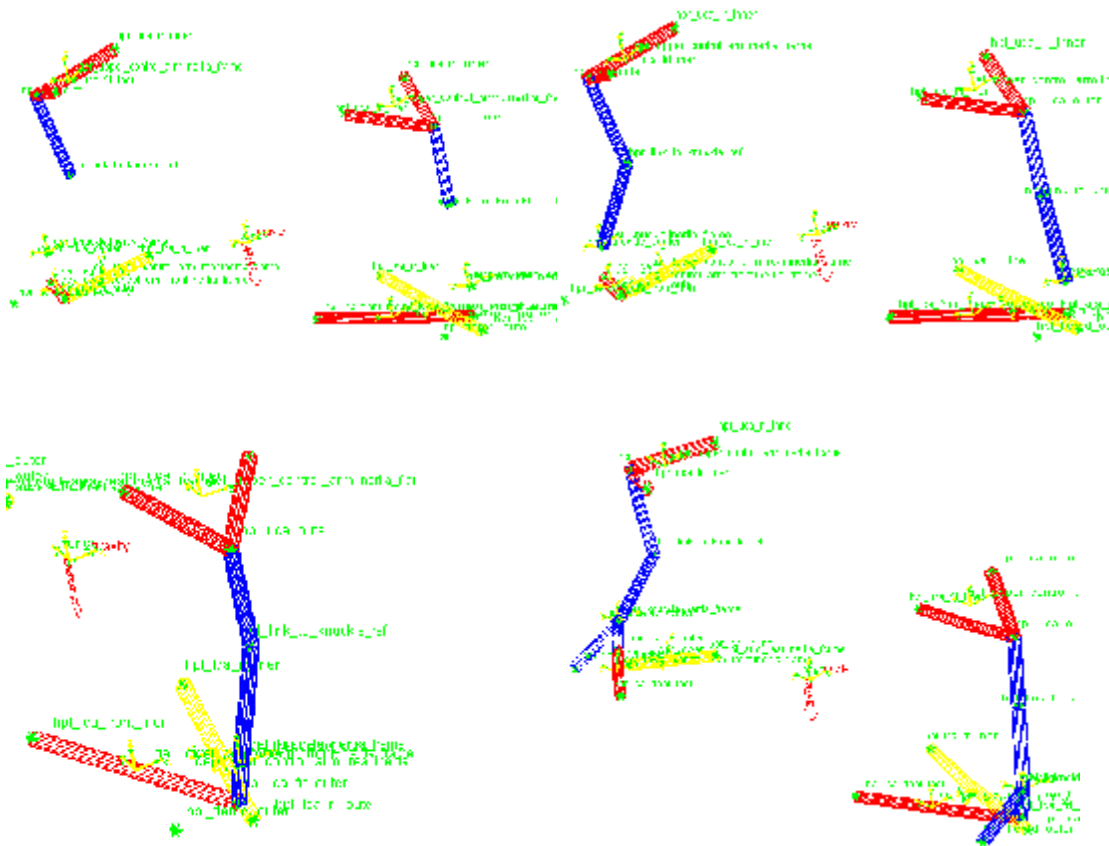
Link Name	knuckle_link4
General Part	._BMW_X5_front_suspension_model.gel_knuckle
Coordinate Reference #1	._BMW_X5_front_suspension_model.ground.hpl_knuckle_center
Coordinate Reference #2	._BMW_X5_front_suspension_model.ground.hpl_tierod_outer
Radius	15
Color	blue
<input type="checkbox"/> Calculate Mass Properties of General Part	
Density	<input checked="" type="radio"/> Material <input type="radio"/> User Entered
Material Type	steel

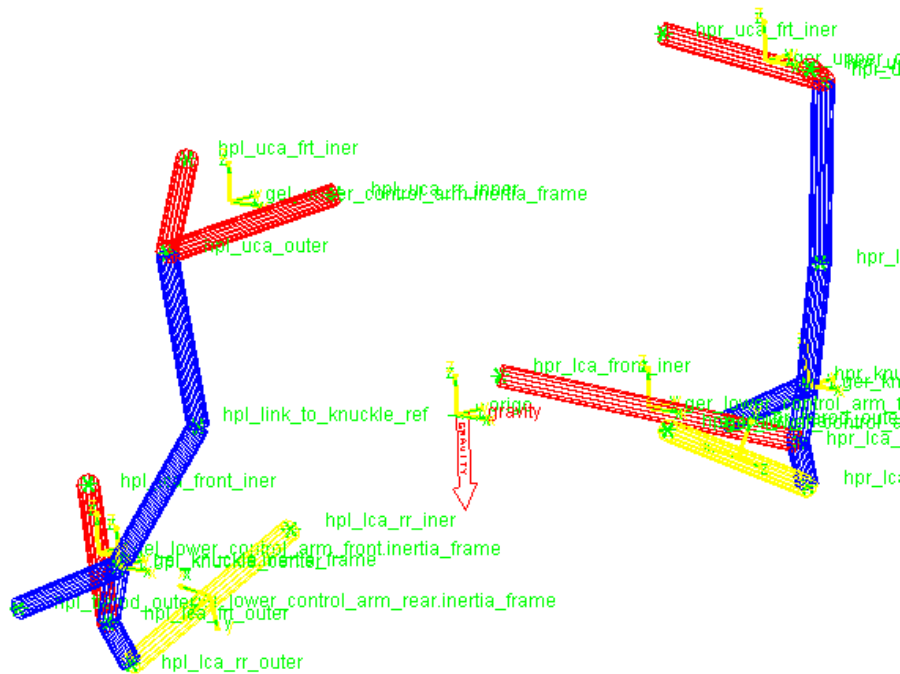
OK Apply Cancel

点击 Apply，输入以下内容：



点击 OK，完成转向节几何体的创建。

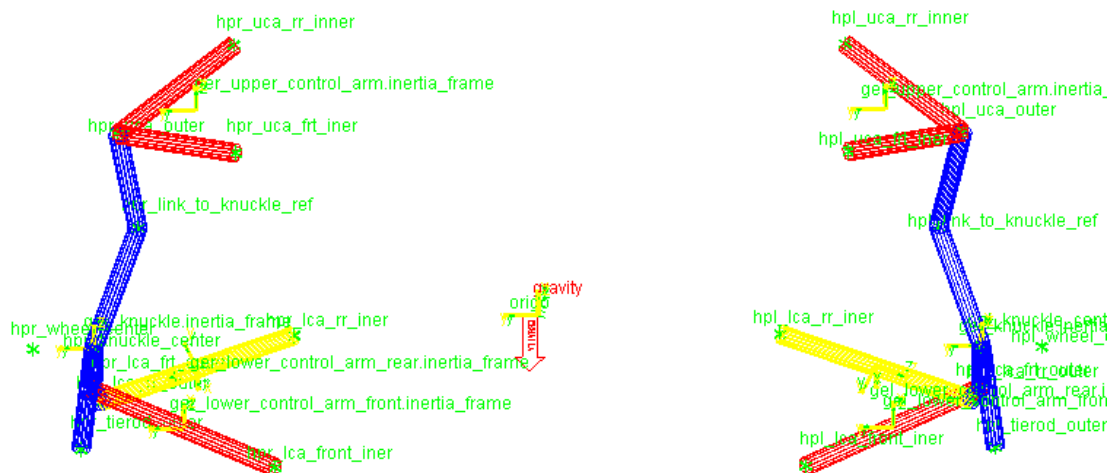
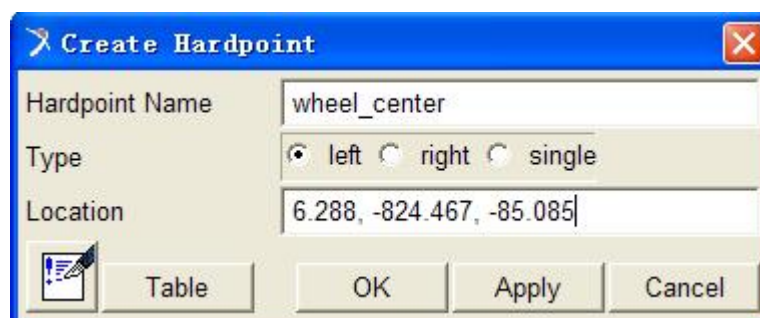




## 2.5 创建轮毂

### 2.5.1 创建轮心点

点击 Build 下拉菜单，选择 Hardpoint>New，填入以下内容



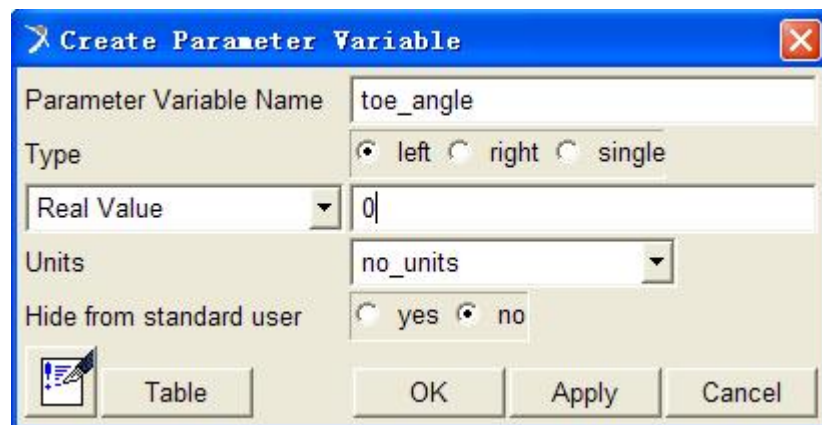
## 2.5.2 创建参数变量

此处创建的参变量主要是轮胎定位参数，在创建轮毂轴承时要用这些参变量来定向（Orientation）。

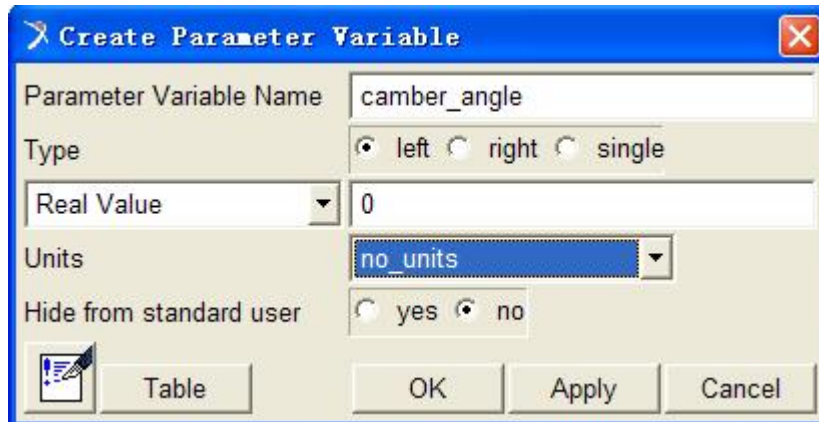
点击 Build 下拉菜单，选择 Parameter Variable>New



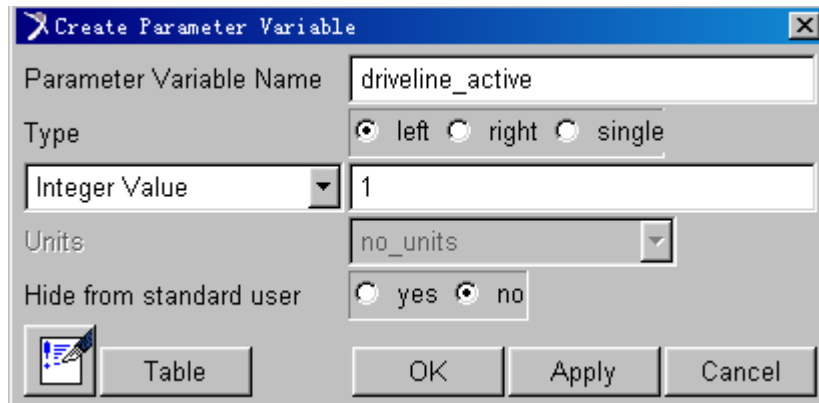
在出现的对话框里输入以下内容，建立前束角参变量：



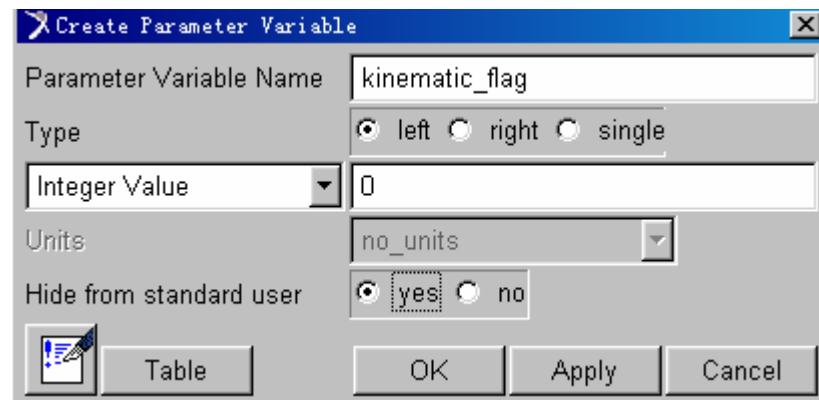
点击 Apply，继续输入以下内容，建立外倾角参变量：



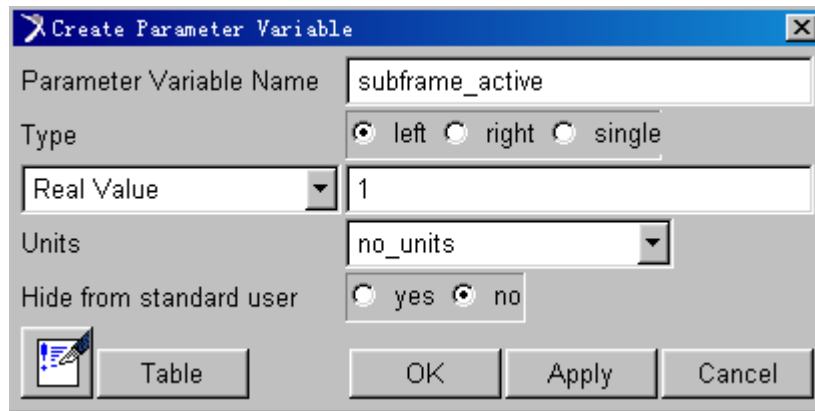
点击 Apply，继续输入以下内容完成驱动轴的激活变量（Activate/Deactivate）



点击 Apply，继续输入以下内容，建立确定 Kinematics 与 Compliance 之间互相切换的参变量：



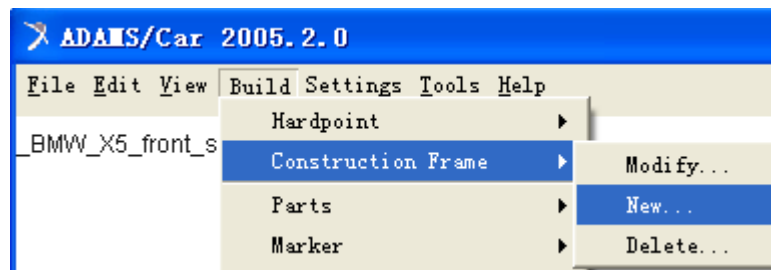
点击 Apply，继续输入以下内容，建立 subframe\_active 参变量：



点击 OK。

### 2.5.3 创建轮心处的 Construction Frame

点击 Build 下拉菜单，选择 Construction Frame>New。



在出现的对话框里填入以下内容：



**Create General Part**

General Part: spindle

Type: ☒ left ☐ right ☐ single

Location Dependency: Delta location from coordinate

Coordinate Reference: .\_BMW\_X5\_front\_suspension\_model.ground.hpl\_wheel\_center

Location: 0,0,0

Location in: ☒ local ☐ global

Orientation Dependency: Delta orientation from coordinate

Construction Frame: .\_BMW\_X5\_front\_suspension\_model.ground.cfl\_wheel\_center

Orientation: 0,0,0

Mass: 1

lxx: 1

lzz: 1

lxy: 1

lyz: 1

Off-Diagonal Terms: ☐

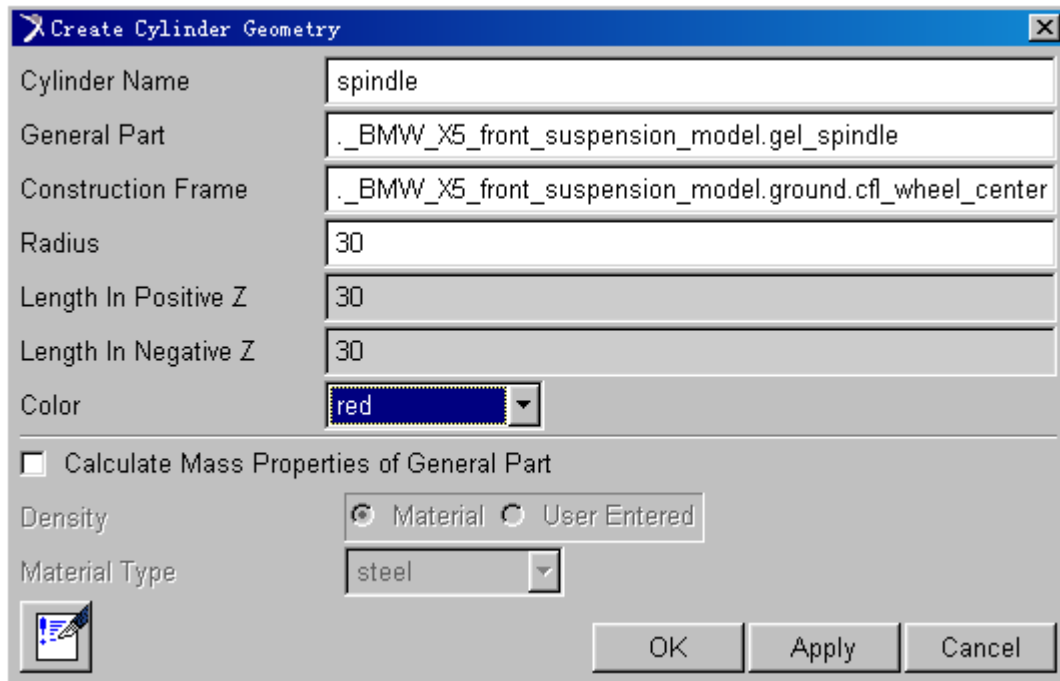
CM Location Relative to Part: [Empty field]

OK Apply Cancel

点击 OK。

### 2.5.5 创建轮毂的几何体

点击 Build 下拉菜单，选择 Geometry>cylinder>New，输入以下内容：



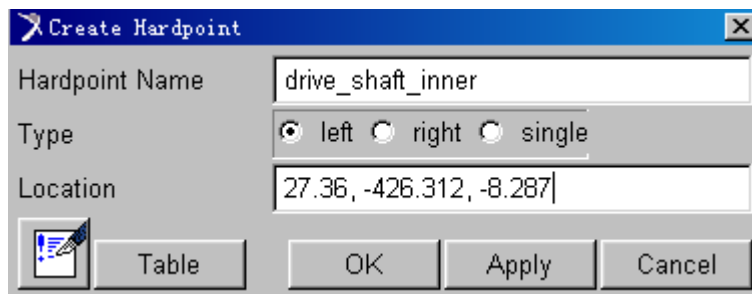
点击 OK，如下图所示：



## 2.6 创建传动轴几何体

### 2.6.1 创建传动轴与变速箱输出端的连接硬点

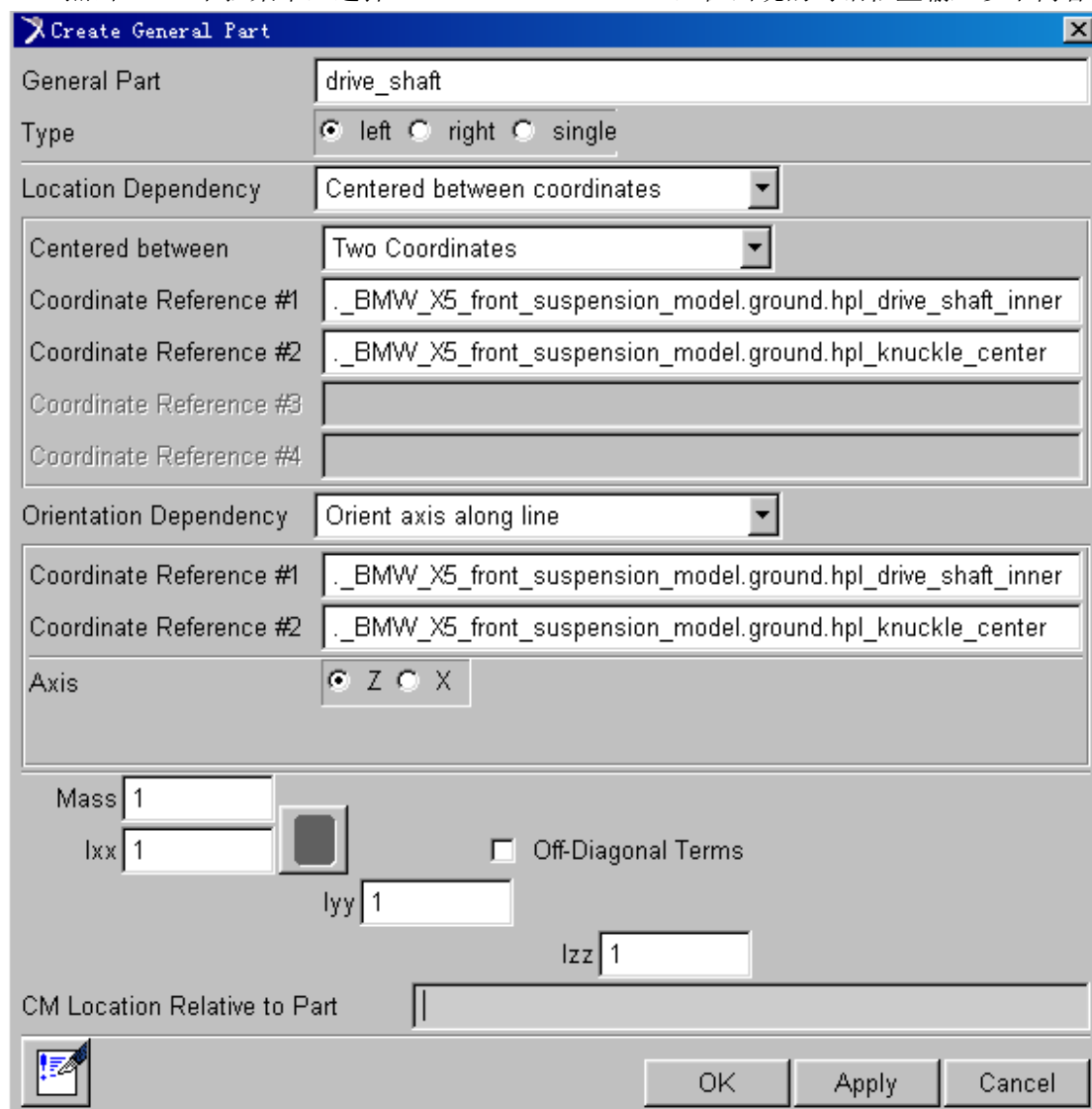
点击 Build 下拉菜单，选择 Hardpoint>New，在出现的对话框里填入以下内容，创建内点：



点击 OK。传动轴外点在本教程中认为与硬点 Knuckle Center 重合，在此不再单独建立。

## 2.6.2 创建传动轴 part

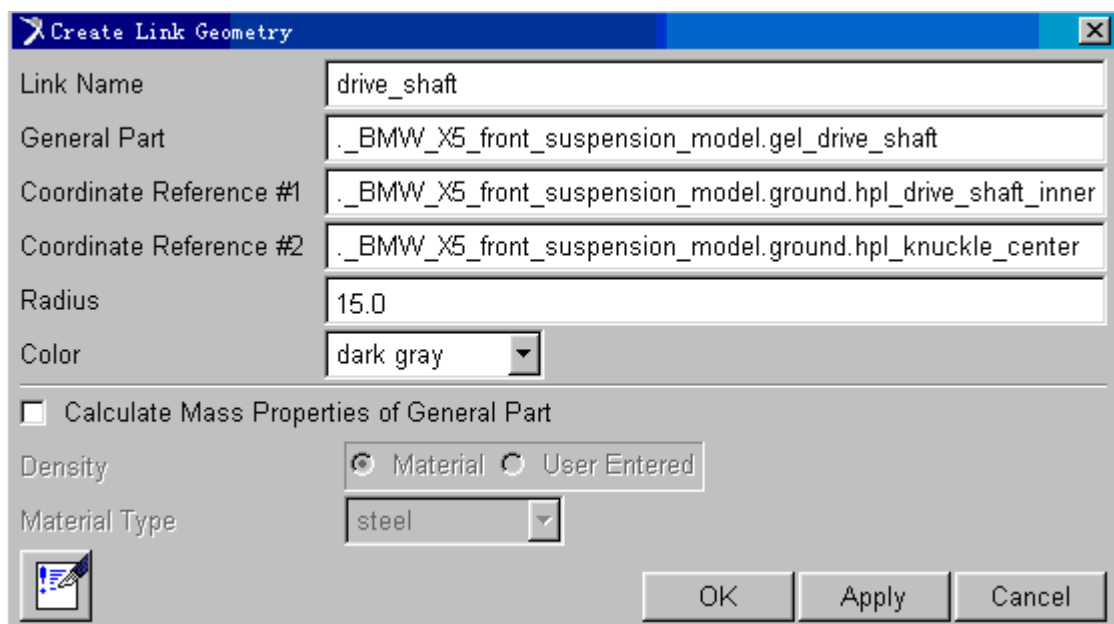
点击 Build 下拉菜单，选择 Parts>General Part>New，在出现的对话框里输入以下内容：



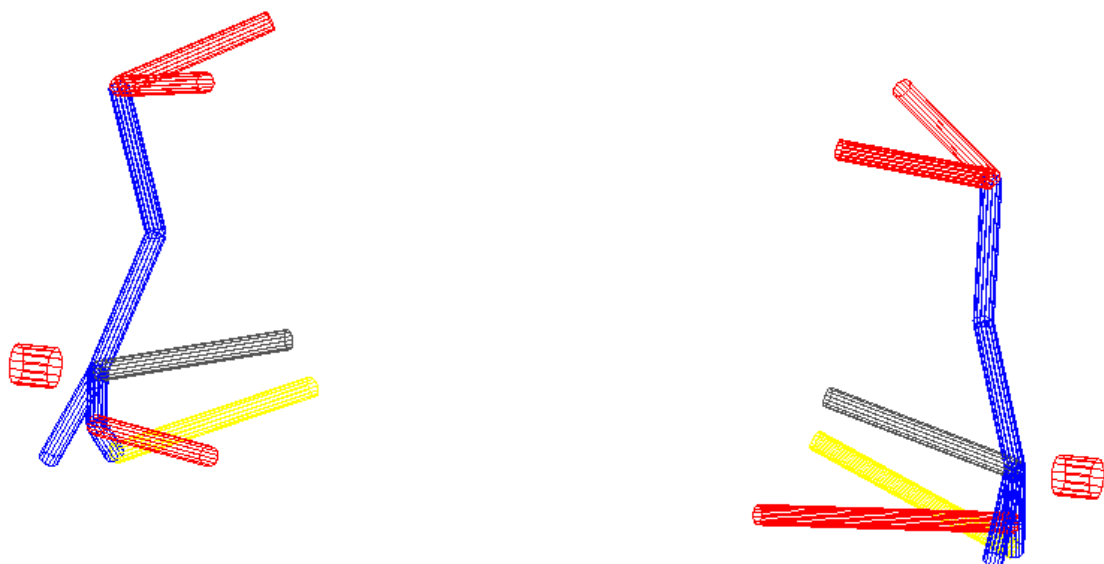
点击 OK。

## 2.6.3 创建传动轴相关的几何体

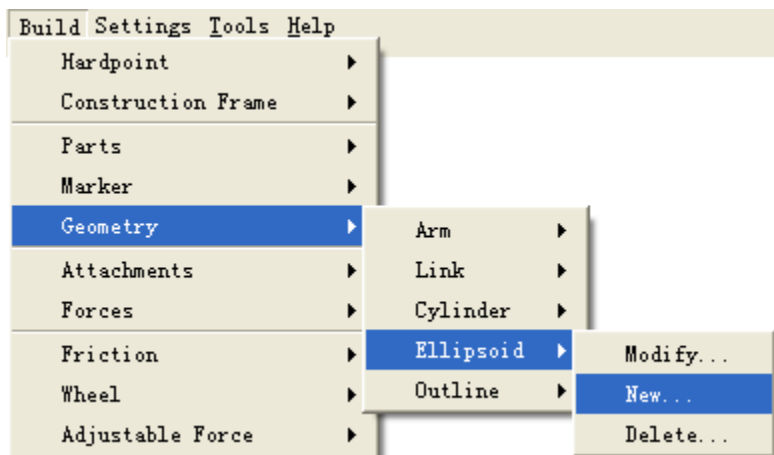
点击 Build 下拉菜单，选择 Geometry>Link>New，输入以下内容：



点击 OK，创建的传动轴几何体如下图所示：




点击 Build 下拉菜单，选择 Geometry>Ellipsoid>New，创建传动轴外端等速万向节球笼几何体。



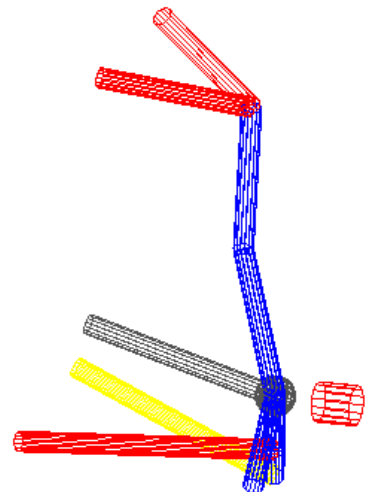
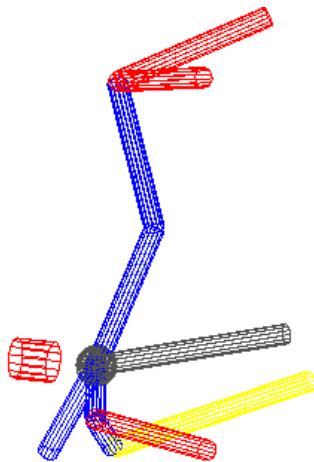
在对话框输入内容如下：

**Create Ellipsoid Geometry**

Ellipsoid Name	cv_housing
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_knuckle_center
Method	scaled off link
Link	._BMW_X5_front_suspension_model.ger_drive_shaft.gralin_drive_shaft
X Scale	2
Y Scale	2
Z Scale	2
Color	dark gray
<input type="checkbox"/> Calculate Mass Properties of General Part	
Density	<input checked="" type="radio"/> Material <input type="radio"/> User Entered
Material Type	steel

 OK Apply Cancel


点击 OK 后如下图所示：



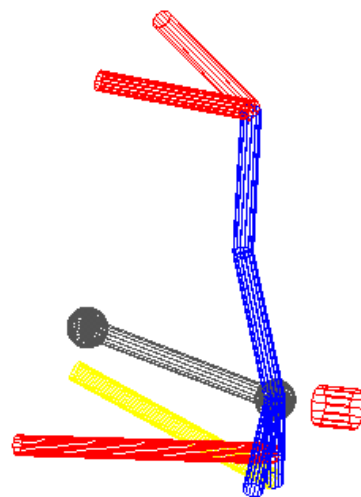
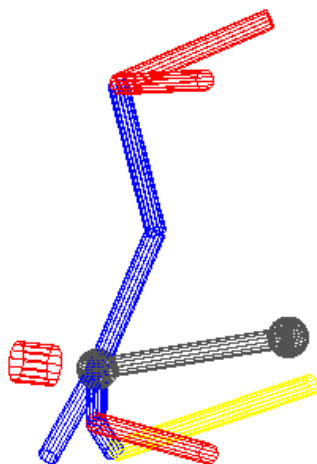
同上述操作，完成传动轴里端球笼几何体创建。

**Create Ellipsoid Geometry**

Ellipsoid Name	tripot_housing
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_drive_shaft_inner
Method	scaled off link
Link	._BMW_X5_front_suspension_model.gel_drive_shaft.gralin_drive_shaft
X Scale	2
Y Scale	2
Z Scale	2
Color	dark gray
<input type="checkbox"/> Calculate Mass Properties of General Part	
Density	<input checked="" type="radio"/> Material <input type="radio"/> User Entered
Material Type	steel

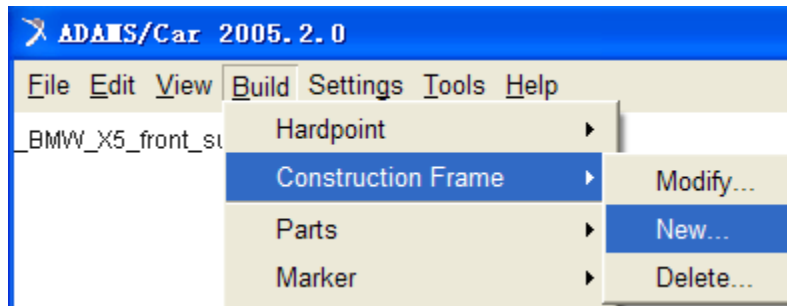
 OK Apply Cancel

点击 OK。

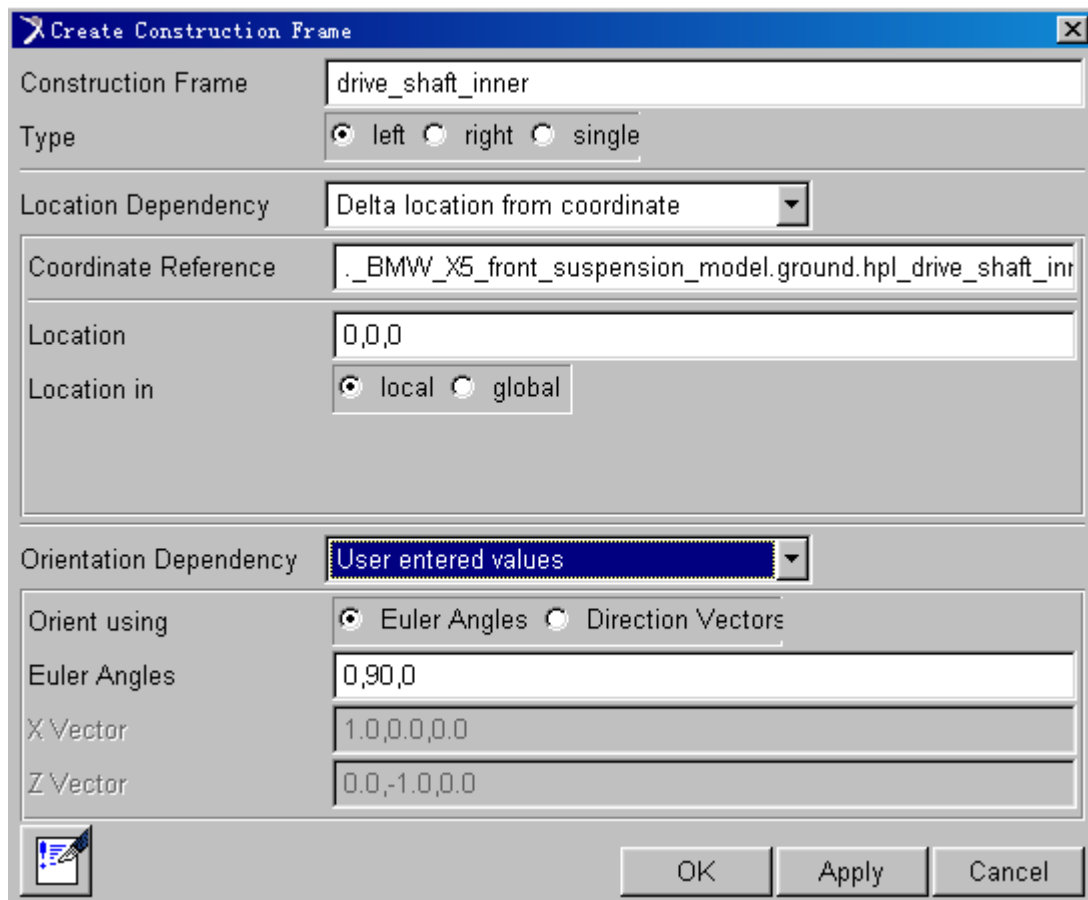


## 2.6.4 创建 tripot 的 Part

为创建 tripot 几何体，需先建立一个 Construction Frame。点击 Build 下拉菜单，选择 Construction Frame>New。



在出现的对话框里输入以下内容：



点击 OK



**Create General Part**

General Part:

Type: ☒ left ☐ right ☐ single

Location Dependency:

Coordinate Reference:

Location:

Location in: ☒ local ☐ global

Orientation Dependency:

Construction Frame:

Orientation:

Mass:


Ixx:

Iyy:

Izz:

Off-Diagonal Terms: ☐

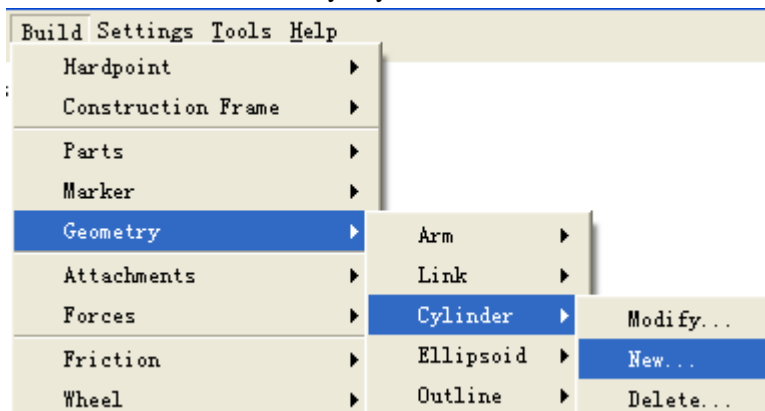
CM Location Relative to Part:



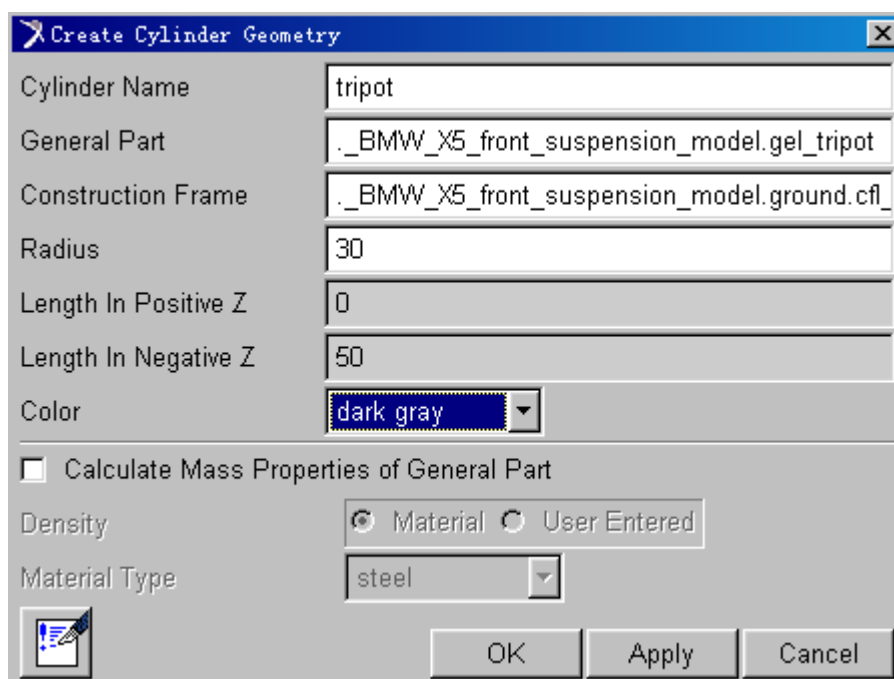
点击 OK。

## 2.6.5 创建 tripot 的几何体

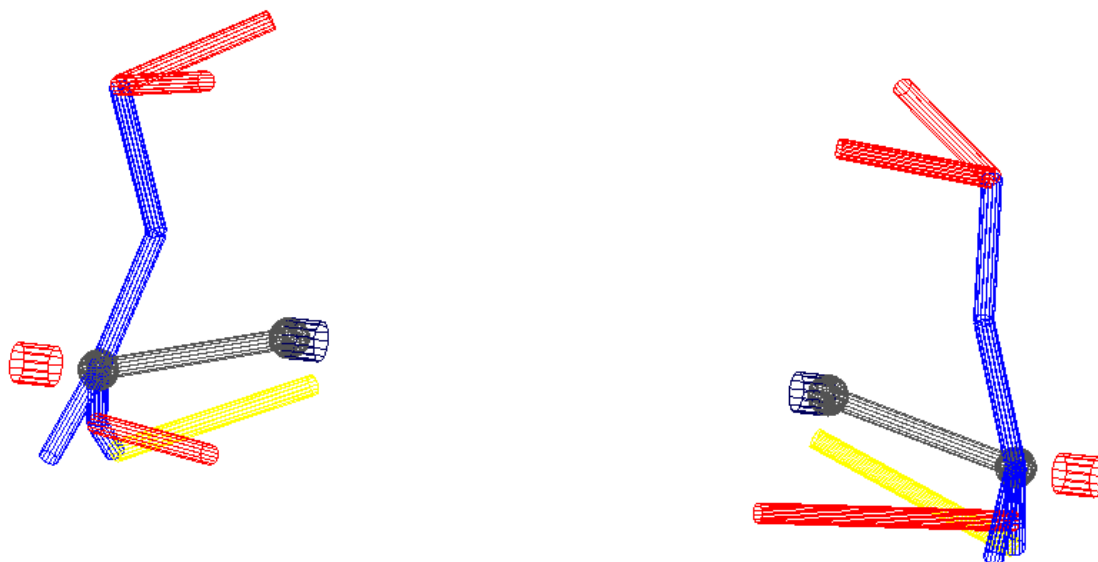
点击 Build 下拉菜单，选择 Geometry>Cylinder>New。



在出现的对话框里输入以下内容：

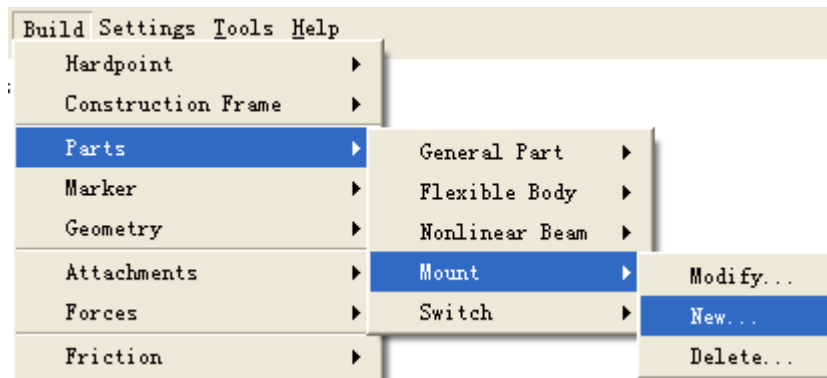


点击 OK，创建的几何体如下图所示：

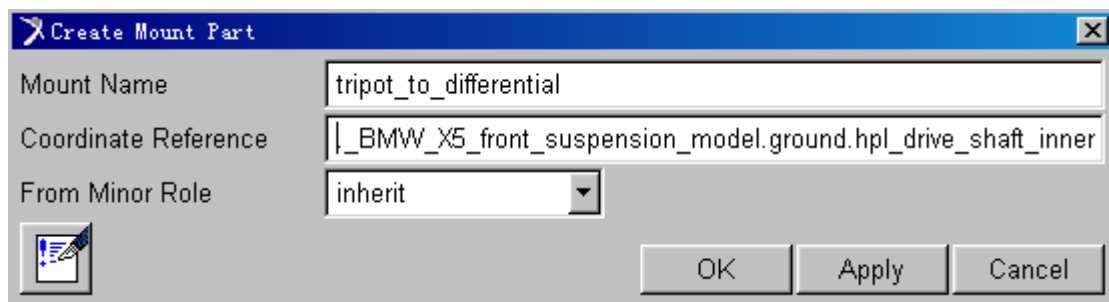


## 2.6.6 创建变速箱输出轴的替代体 Mount Part

点击 Build 下拉菜单，选择 Parts>Mount>New。



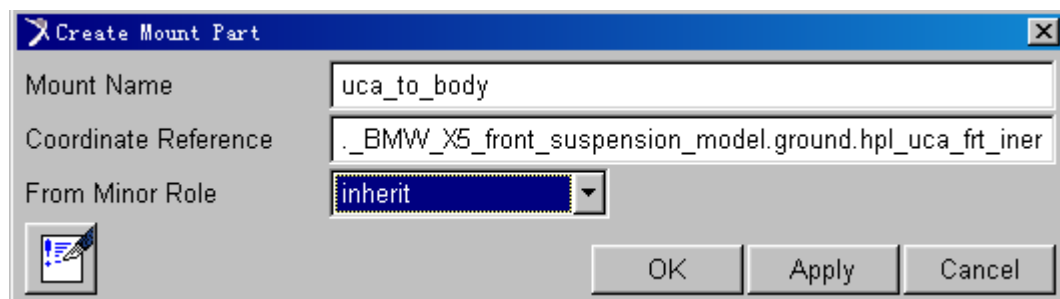
在出现的对话框里输入以下内容：



点击 OK。

## 2.6.7 创建上控制臂处车身的替代体 Mount Part

点击 Build 下拉菜单，选择 Parts>Mount>New，在出现的对话框里输入以下内容：

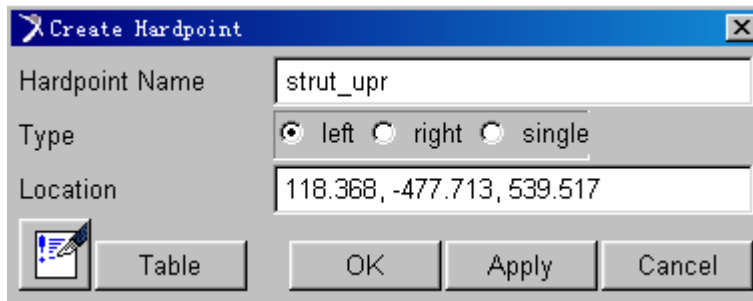


点击 OK。

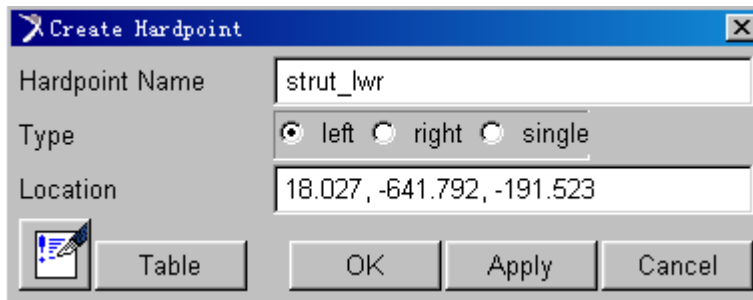
## 2.7 创建减振器

### 2.7.1 创建减振器上下硬点

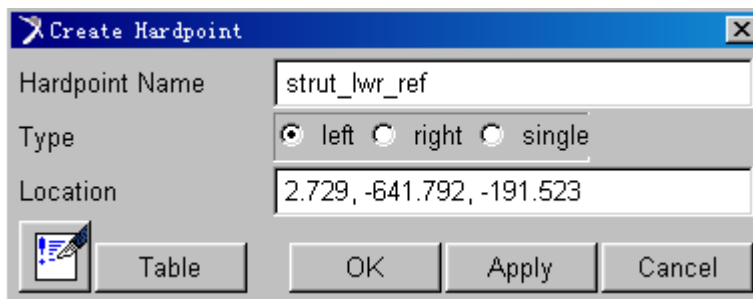
减振器上点：



减振器下点:



减振器吊耳处衬套轴线上一参考点:



## 2.7.2 创建减振器上下体 Part

1)减振器上体

从菜单选择 Build>Parts>General Part>New, 设定对话框如下图所示:

**Create General Part**

General Part:

Type: ☒ left ☐ right ☐ single

Location Dependency:

Coordinate Reference #1:

Coordinate Reference #2:

Relative Location (%):

Orientation Dependency:

Coordinate Reference:

Axis: ☒ Z ☐ X

Mass:


Ixx:

Iyy:

Izz:

Off-Diagonal Terms: ☐

CM Location Relative to Part:



2) 减振器下体

**Create General Part**

General Part:

Type: ☒ left ☐ right ☐ single

Location Dependency:

Coordinate Reference #1:

Coordinate Reference #2:

Relative Location (%):

Orientation Dependency:

Coordinate Reference:

Axis: ☒ Z ☐ X

Mass:


Ixx:

Iyy:

Izz:

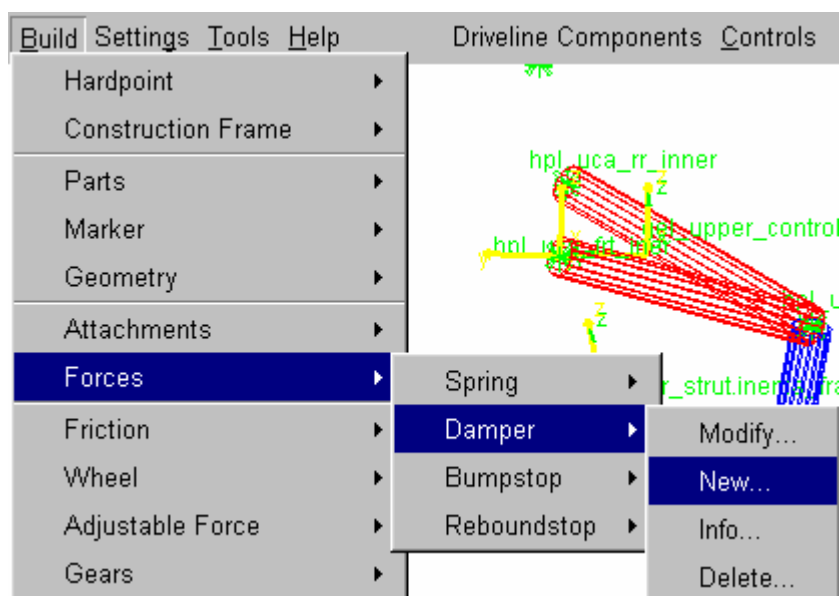
Off-Diagonal Terms: ☐

CM Location Relative to Part:

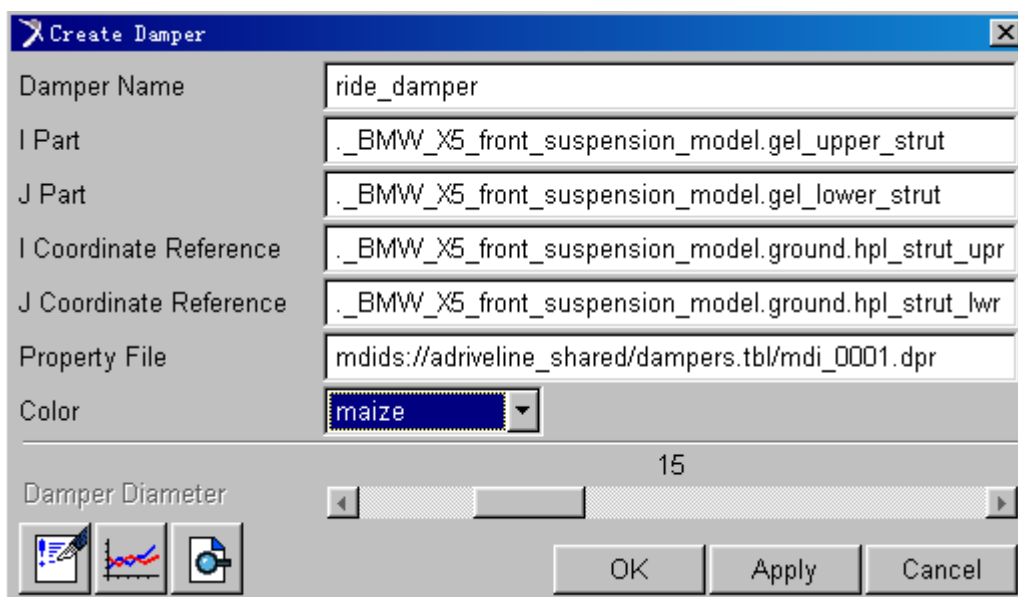


### 2.7.3 创建 Damper

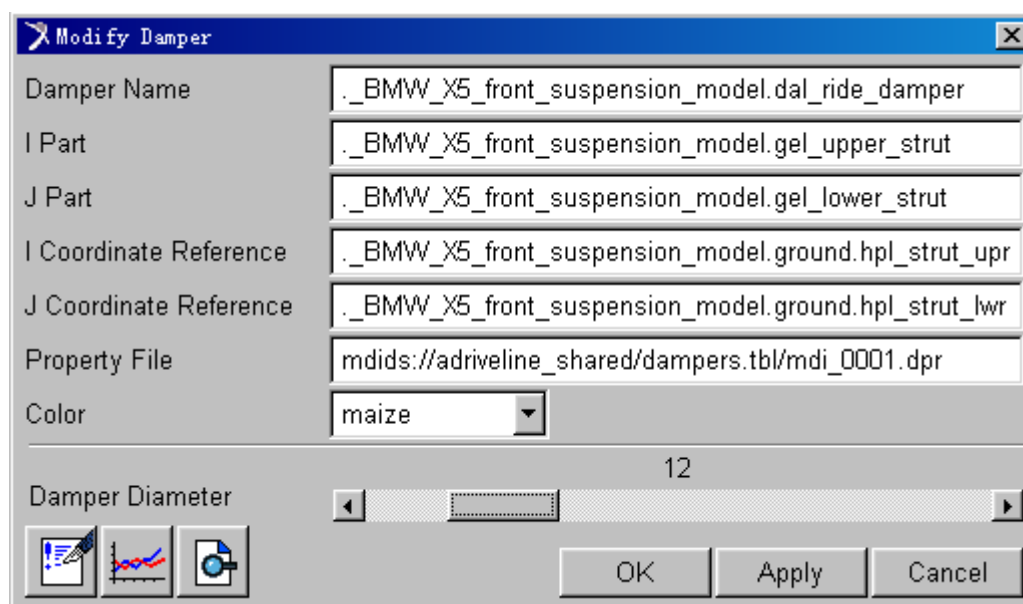
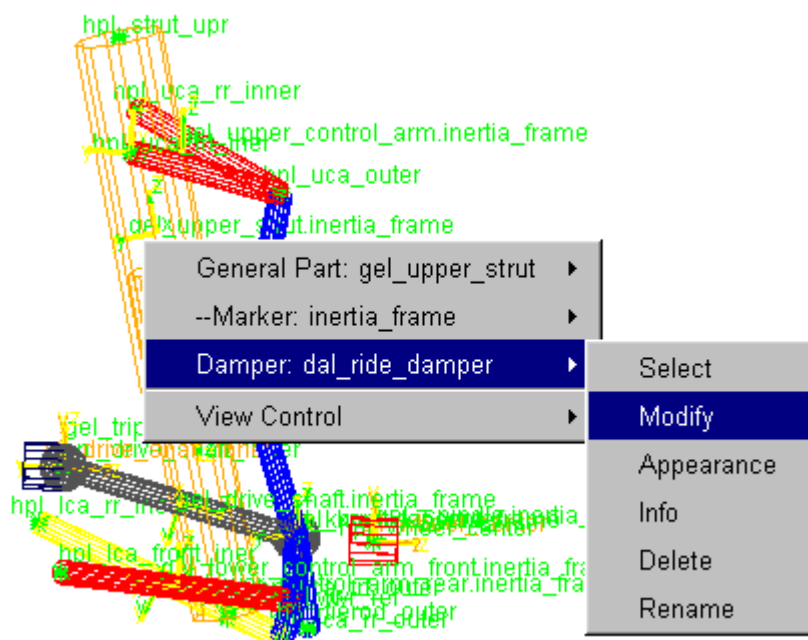
点击 Build 下拉菜单，选择 Forces>Damper>New



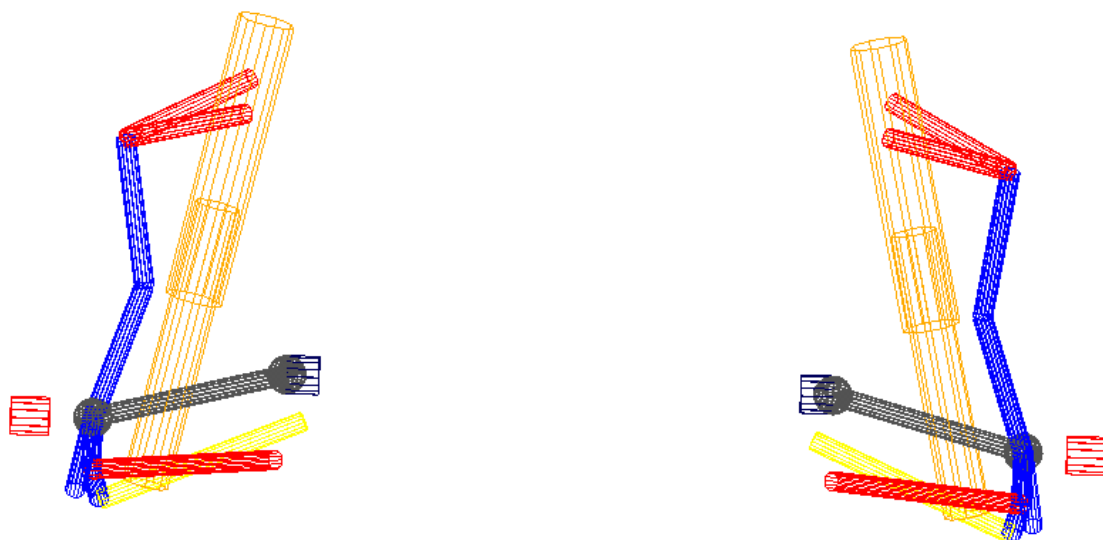
在出现的对话框里输入以下内容：



点击 OK，创建 Damper。在出现的图形里右击鼠标，选择刚创建的 Damper，在箭头后出现的列表里选择 Modify，可以更改刚创建的 Damper，如修改外观直径，特性文件等。本例中是将减振器直径由创建时默认的 15 修改为 12。



点击 OK，如下图所示：



## 2.7.4 创建减振器上端的车身替代体 Mount Part

首先在该处创建一个 Construction Frame，如下图所示：

Create Construction Frame

Construction Frame

top\_mount\_extension

Type

☒ left
 ☐ right
 ☐ single

Location Dependency

Delta location from coordinate

Coordinate Reference

.\_BMW\_X5\_front\_suspension\_model.ground.hpl\_strut\_upr

Location

0,0,50

Location in

☒ local
 ☐ global

Orientation Dependency

User entered values

Orient using

☒ Euler Angles
 ☐ Direction Vectors

Euler Angles

0,0,0

X Vector

1.0,0.0,0.0

Z Vector

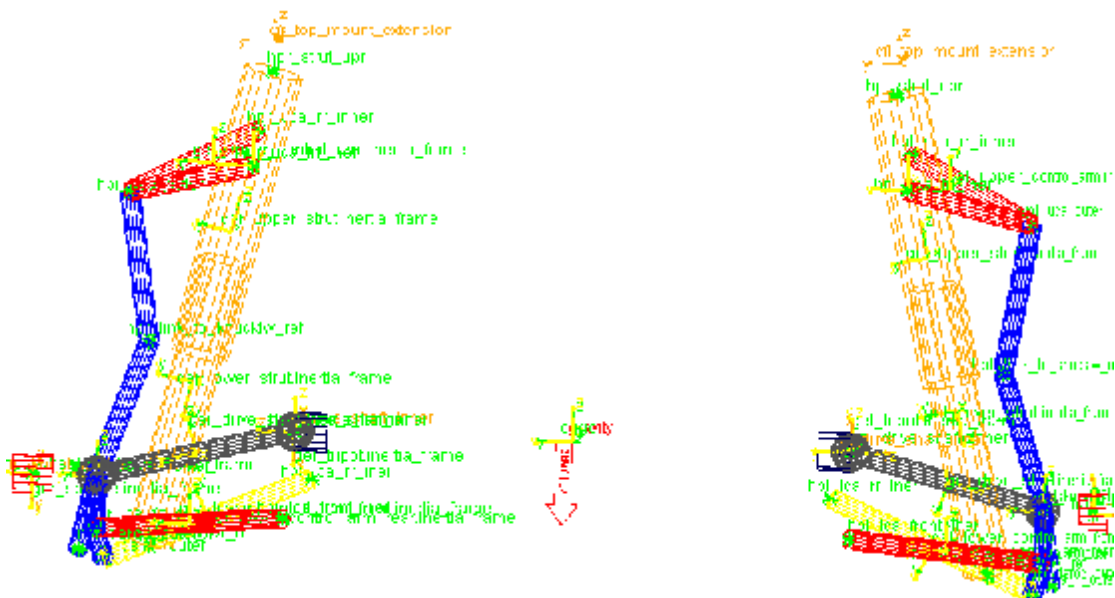
0.0,0.0,1.0

OK

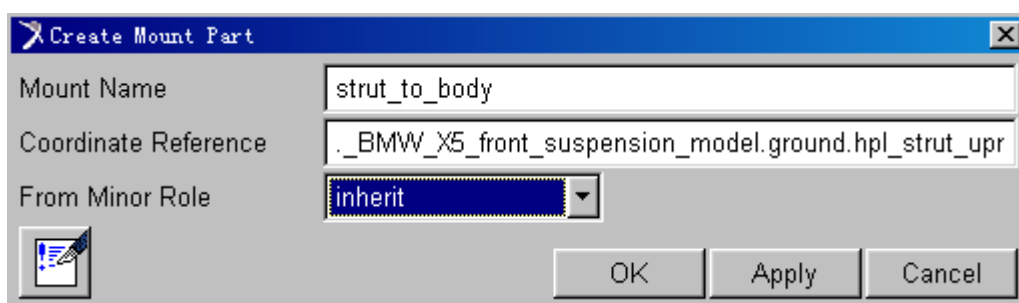
Apply

Cancel

点击 OK。



创建减振器上端处车身替代体 Mount part，点击 Build 下拉菜单，选择 Parts>Mount>New，在出现的对话框里输入以下内容：



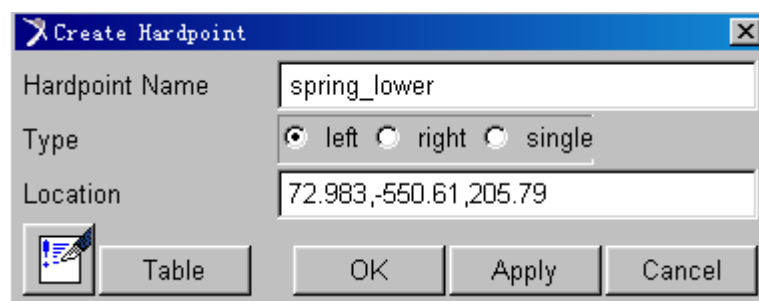
点击 OK。

## 2.8 创建弹簧

### 2.8.1 创建弹簧上下硬点

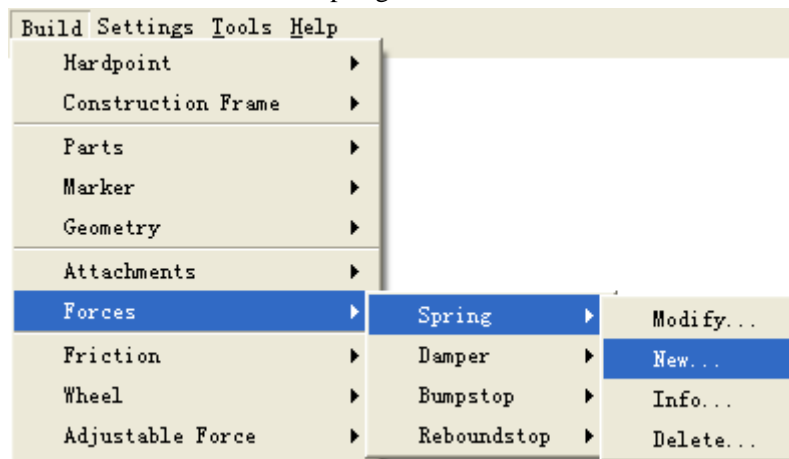
弹簧上点：采用减振器上点

弹簧下点：

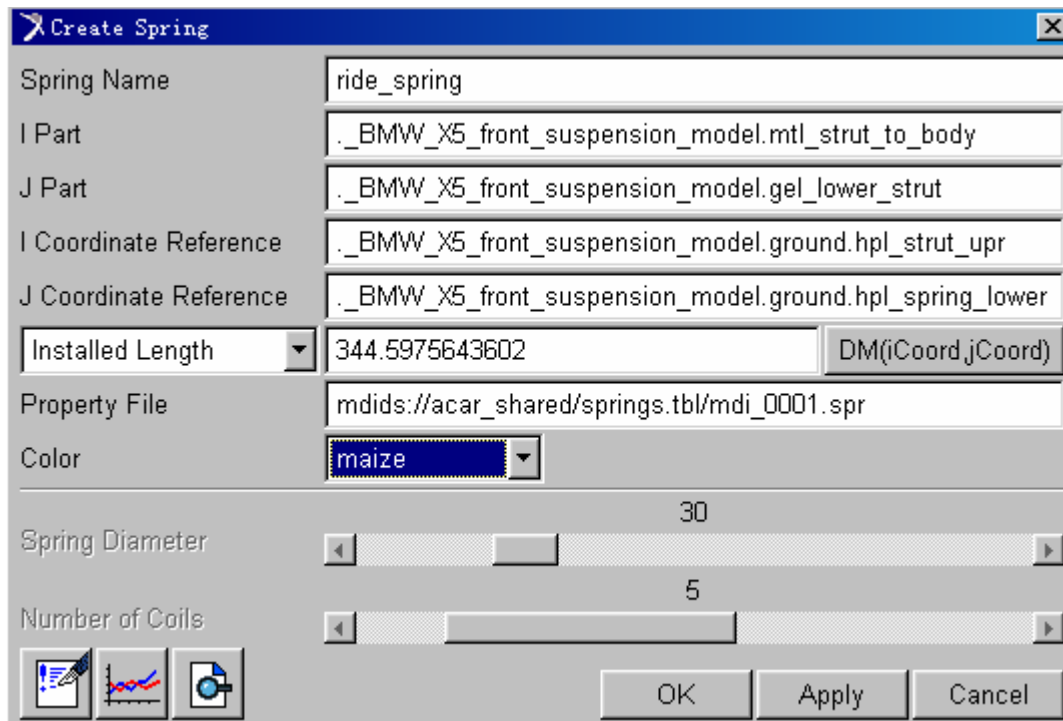


## 2.8.2 创建弹簧

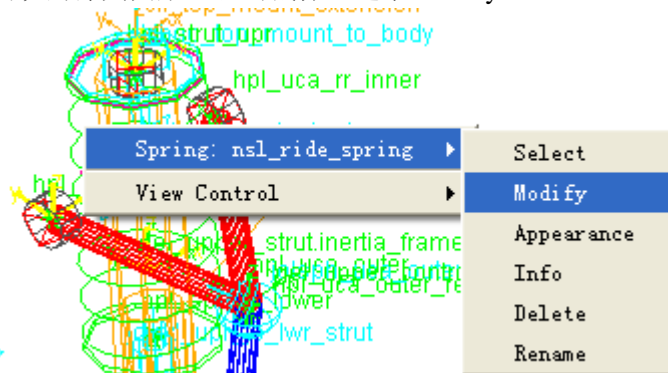
点击下拉菜单 Build, 选择 Force>Spring>New



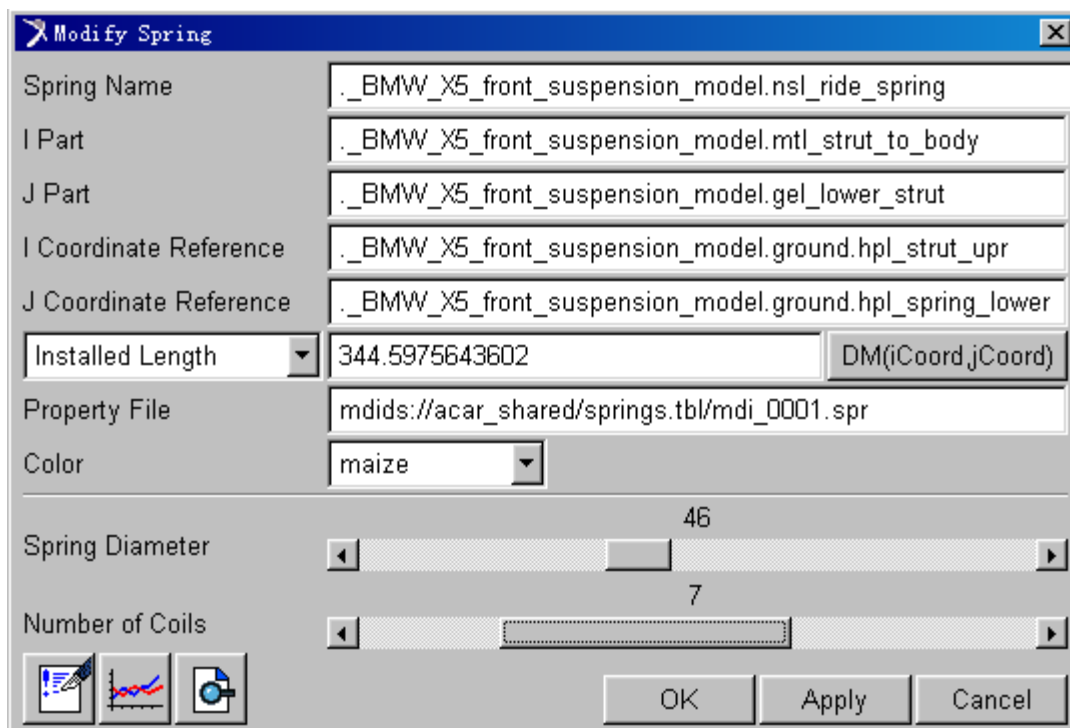
在出现的对话框里输入以下内容:



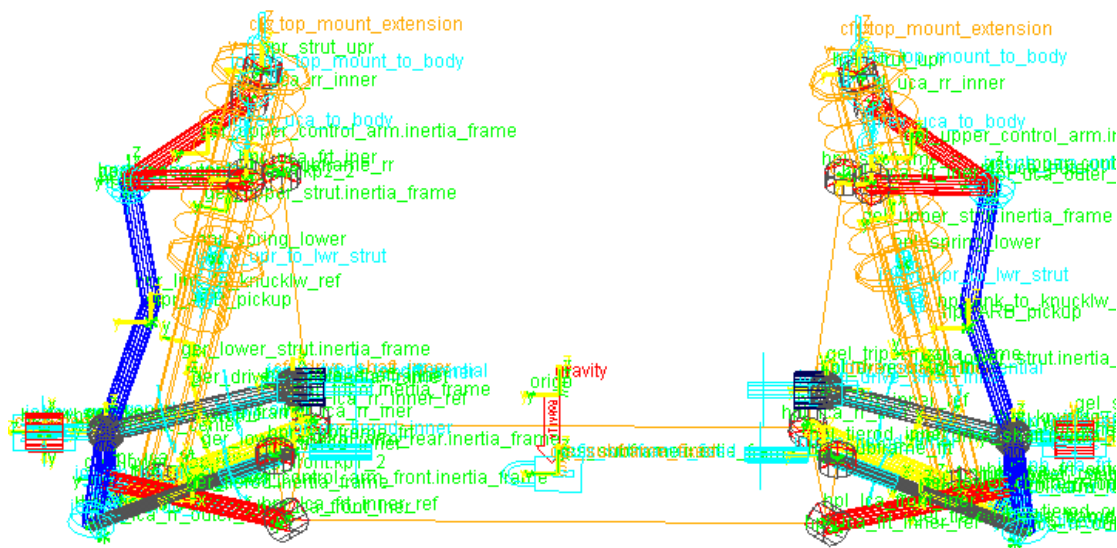
点击 OK, 然后在出现的弹簧图形上右击鼠标, 选中 Modify



在出现的对话框里可以调整弹簧的圈数和外径。



点击 OK，如下图所示：

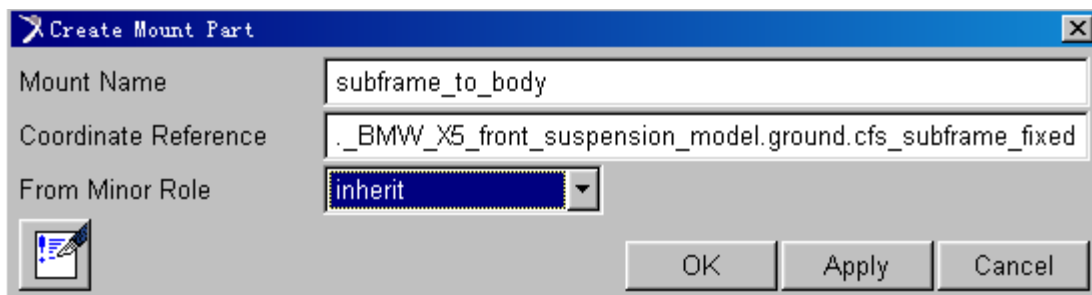


## 2.9 创建前副车架

### 2.9.1 创建 Construction Frame

在前副车架与车身的固定点处创建 Construction Frame

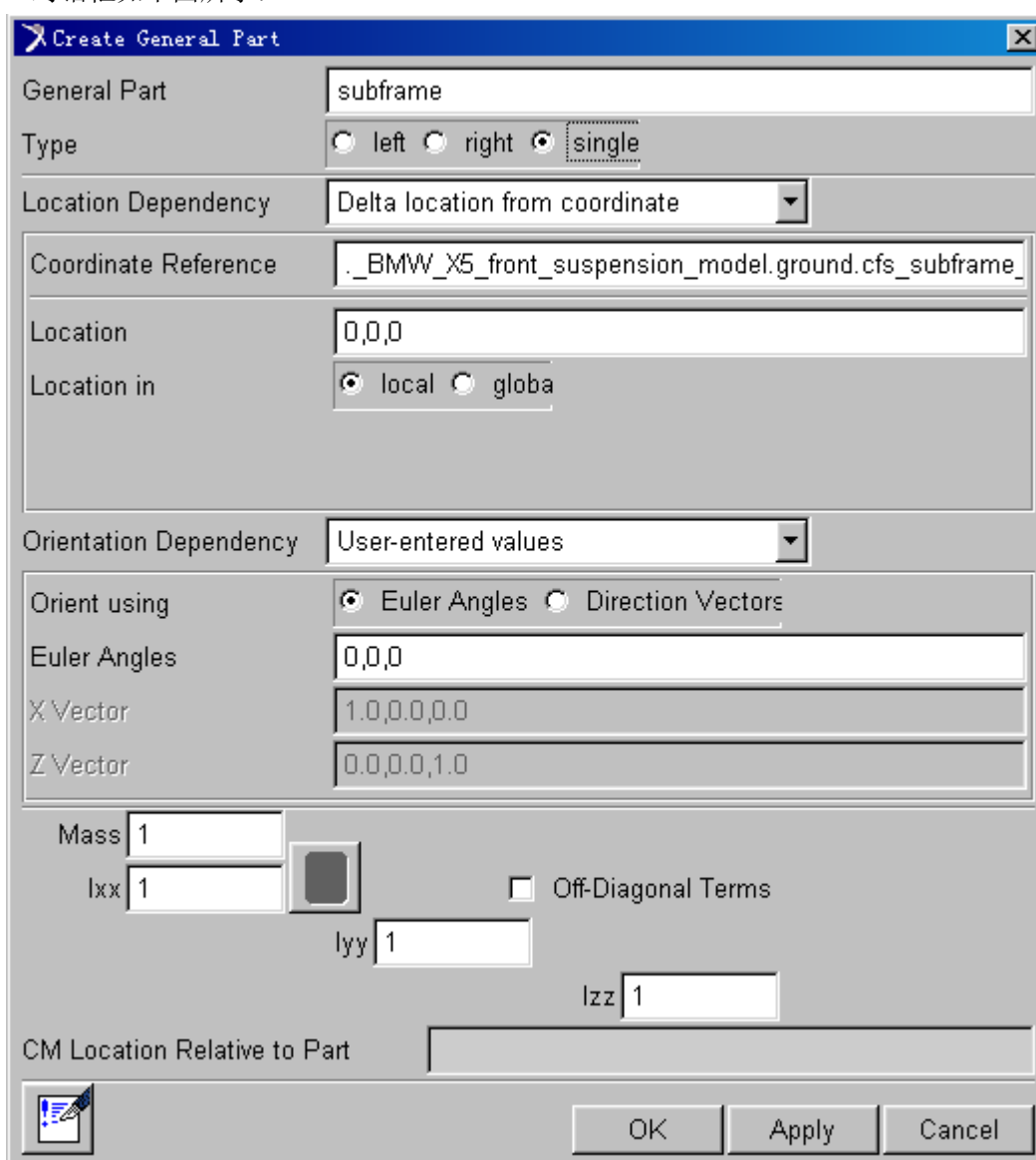




点击 OK。

## 2.9.2 创建前副车架 Part

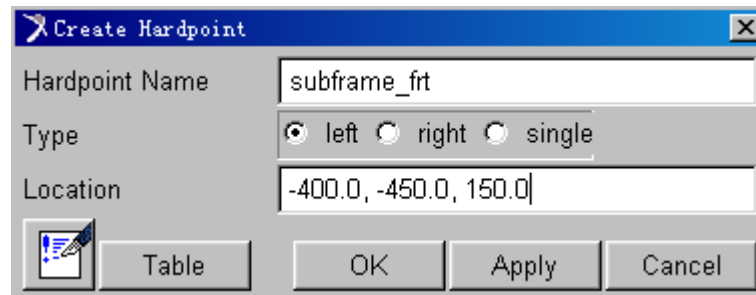
对话框如下图所示：



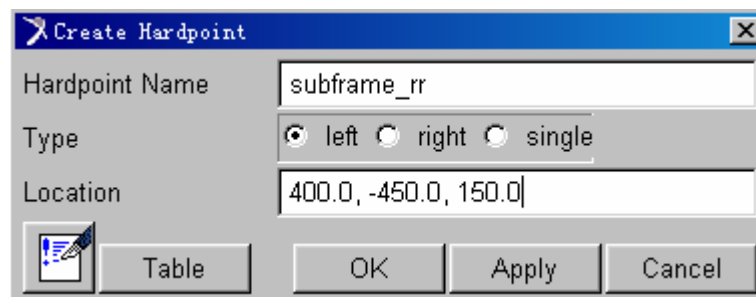
点击 OK。

### 2.9.3 创建前副车架轮廓线 Outline

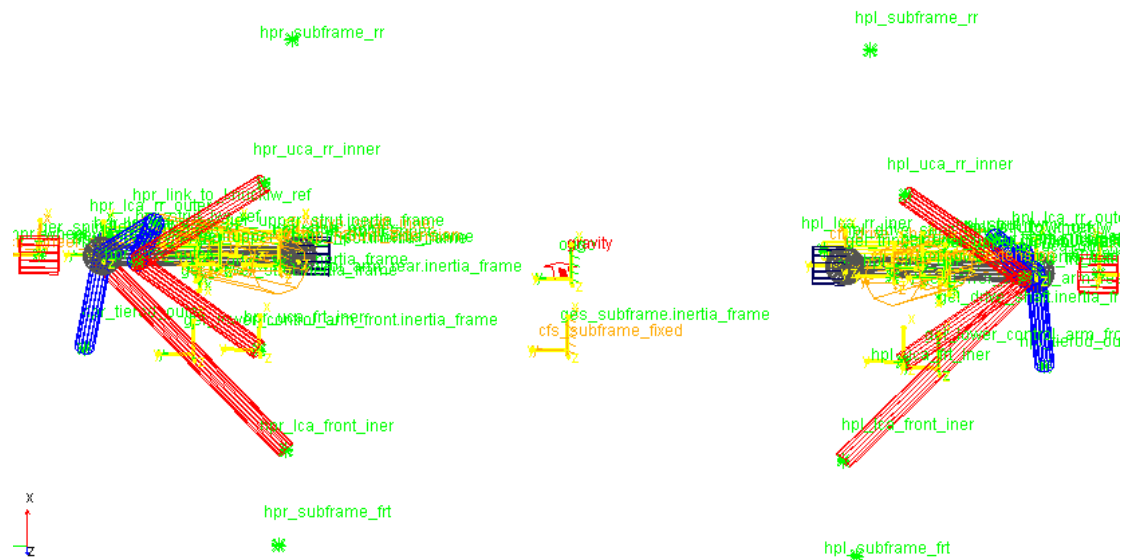
创建前副车架前衬套处硬点



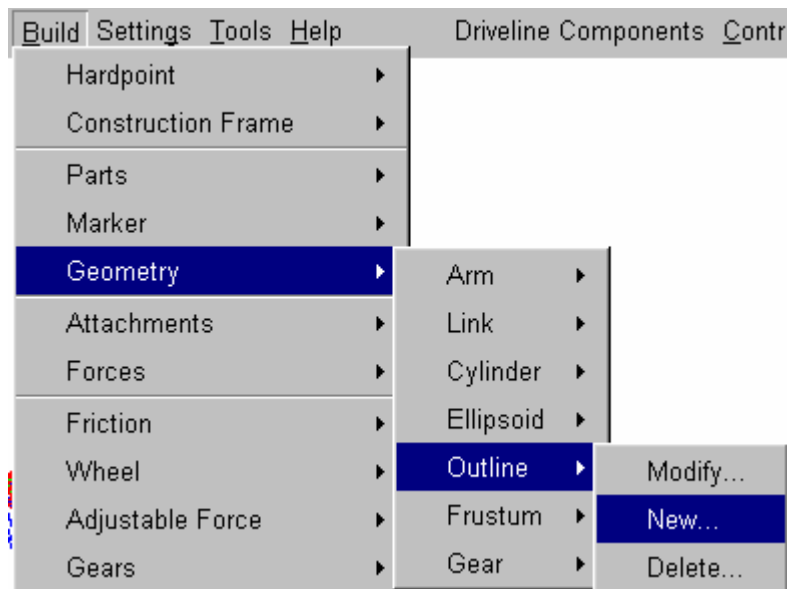
点击 Apply，输入以下内容创建前副车架后衬套处硬点：



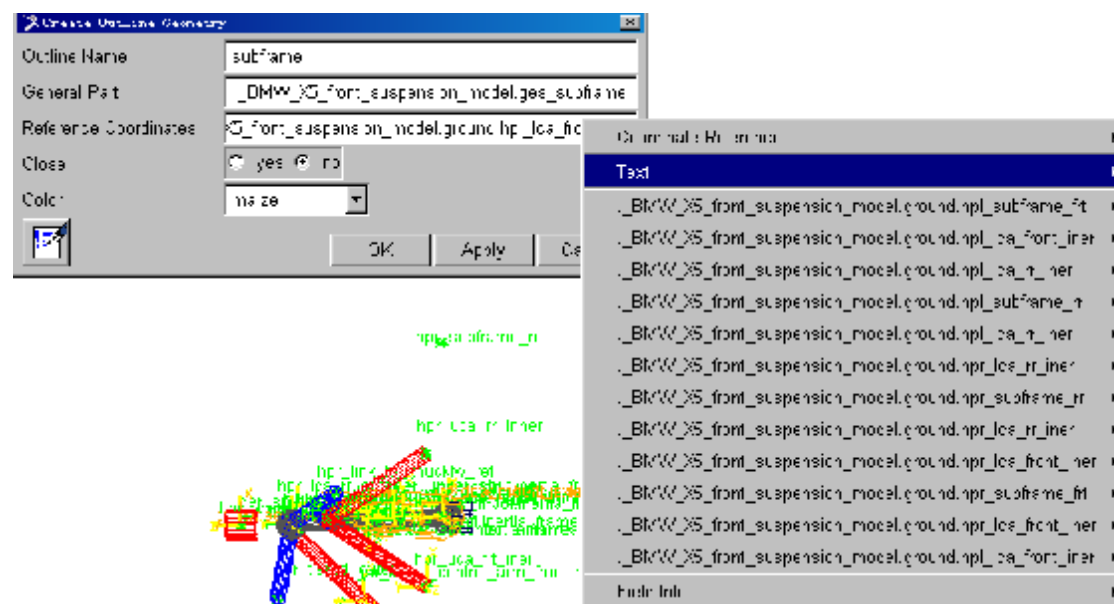
点击 OK。



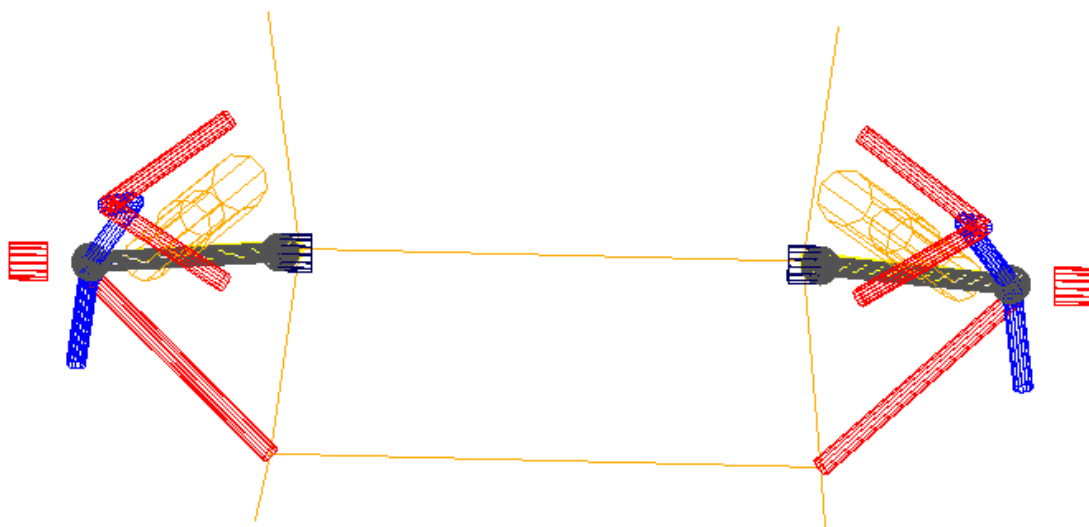
点击 Build 下拉菜单，选择 Geometry>Outline>New。



在出现的对话框里输入以下内容，其中 Reference Coordinates 一栏，右击鼠标，选择 Pick，依次按下图所列点取：



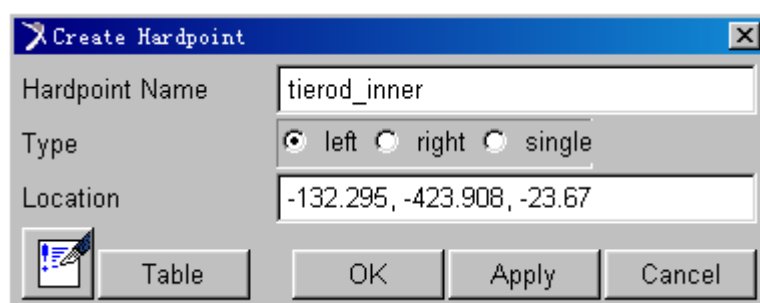
点击 OK 后所创建的副车架 Outline 如下图所示：



## 2.10 创建转向横拉杆

### 2.10.1 创建硬点（下前控制臂内外点）

点击 Build 下拉菜单，选择 Hardpoint>New，在出现的对话框里填入以下内容：



点击 OK，创建转向横拉杆内点。

### 2.10.2 创建下前控制臂 part

点击 Build 下拉菜单，选择 Parts>General Part>New，在出现的对话框里填入以下内容：

**Create General Part**

General Part: tierod

Type: ☒ left ☐ right ☐ single

Location Dependency: Centered between coordinates

Centered between: Two Coordinates

Coordinate Reference #1: .\_BMW\_X5\_front\_suspension\_model.ground.hpl\_tierod\_inner

Coordinate Reference #2: .\_BMW\_X5\_front\_suspension\_model.ground.hpl\_tierod\_outer

Coordinate Reference #3:

Coordinate Reference #4:

Orientation Dependency: Orient axis along line

Coordinate Reference #1: .\_BMW\_X5\_front\_suspension\_model.ground.hpl\_tierod\_inner

Coordinate Reference #2: .\_BMW\_X5\_front\_suspension\_model.ground.hpl\_tierod\_outer

Axis: ☒ Z ☐ X

Mass: 1


Ixx: 1

Iyy: 1

Izz: 1

Off-Diagonal Terms: ☐

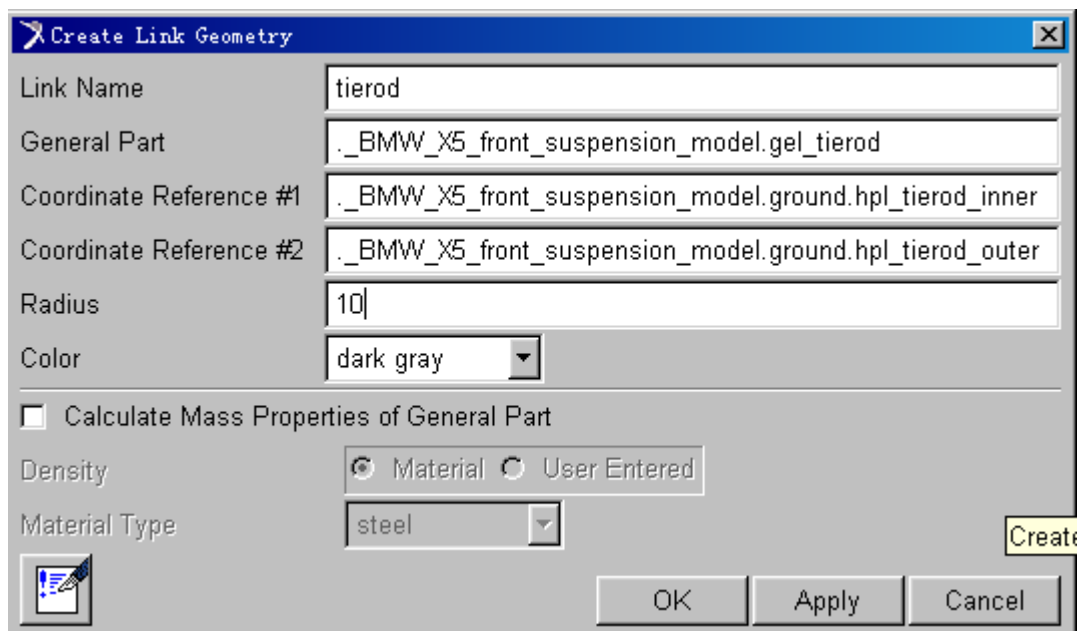
CM Location Relative to Part:

 OK Apply Cancel

点击 OK 完成转向横拉杆 part 的创建。

### 2.10.3 创建下前控制臂几何体

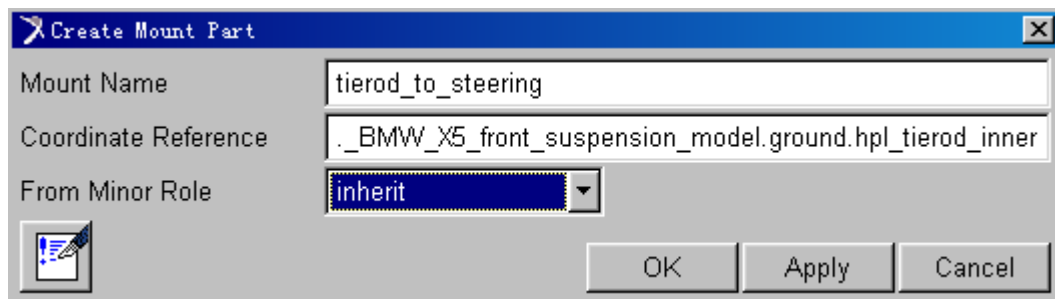
点击 Build 下拉菜单，选择 Geometry>Link>New，在出现的对话框里填入如下内容：



点击 OK。

#### 2.10.4 创建转向机齿条的替代体 Mount Part

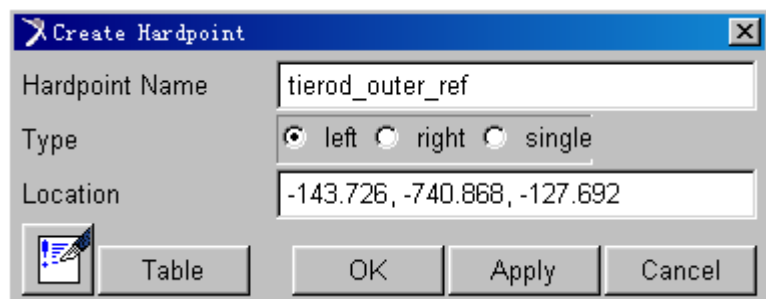
点击 Build 下拉菜单，选择 Parts>Mount>New，在出现的对话框里输入以下内容：



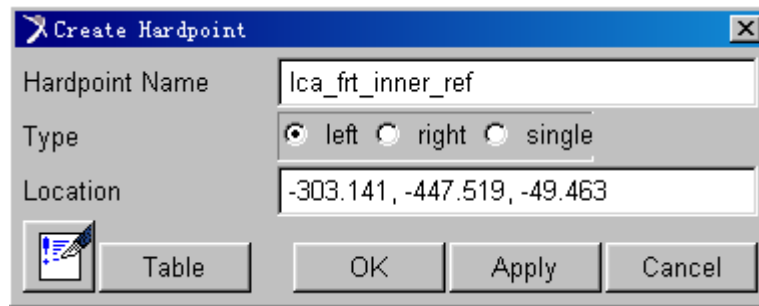
点击 OK。

#### 2.11 创建确定球销或衬套轴线的几个参考点

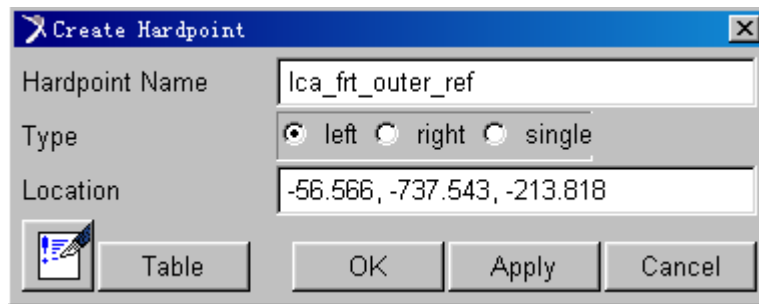
点击 Build 下拉菜单，选择 Hard Points>New，输入以下内容：



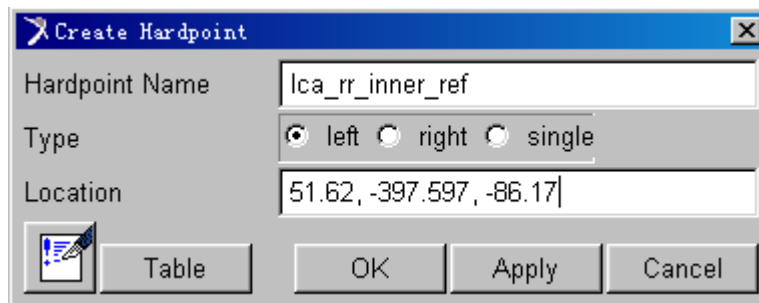
点击 Apply，创建转向横拉杆外点球销轴线参考点，接着输入以下内容：



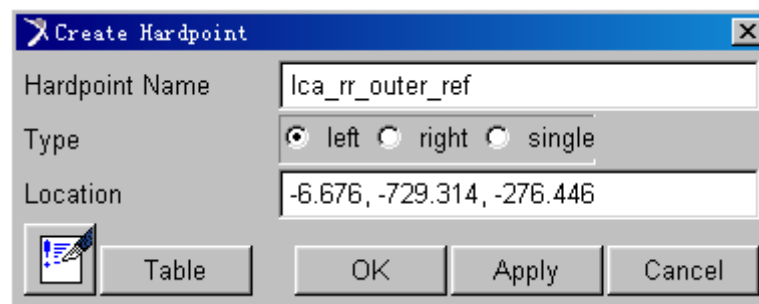
点击 Apply，创建下前控制臂内点衬套轴线参考点，接着输入以下内容：



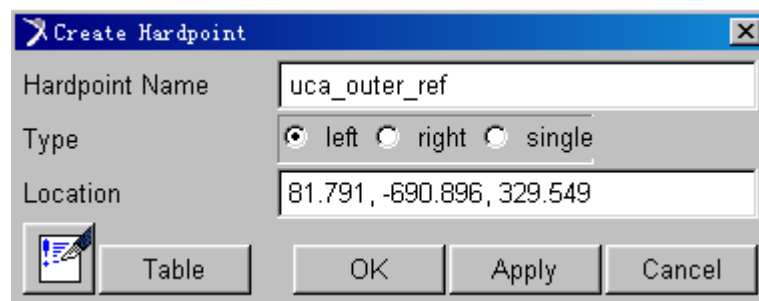
点击 Apply，创建下前控制臂外点球销轴线参考点，接着输入以下内容：



点击 Apply，创建下后控制臂内点衬套轴线参考点，接着输入以下内容：



点击 Apply，创建下后控制臂外点球销轴线参考点，接着输入以下内容：



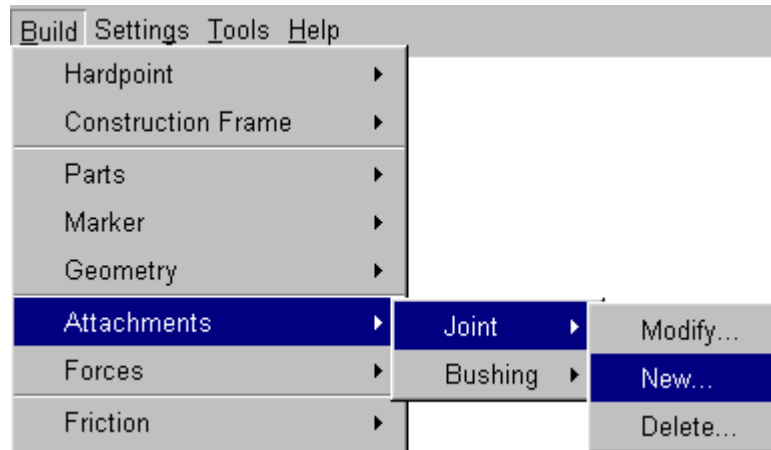
点击 Apply，创建上控制臂外点球销轴线参考点。

## 2.12 创建 part 之间的连接

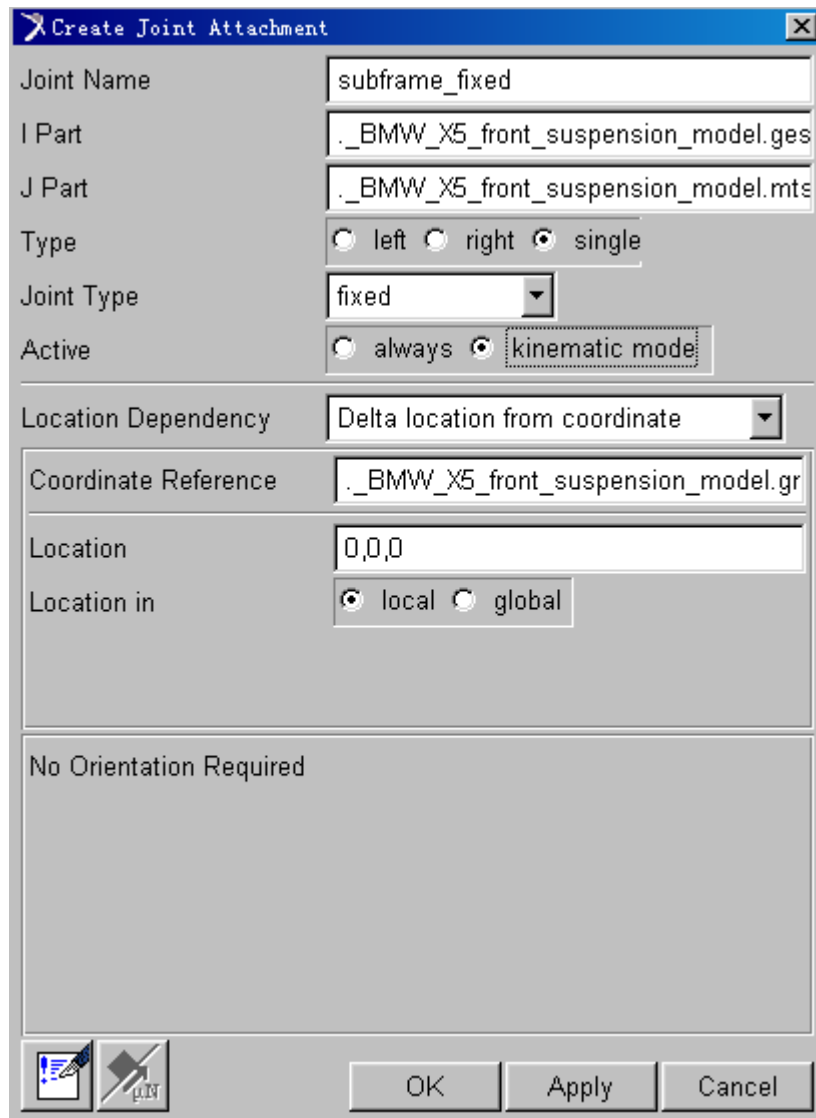
### 2.12.1 前副车架

1) 创建前副车架与车身固定连接

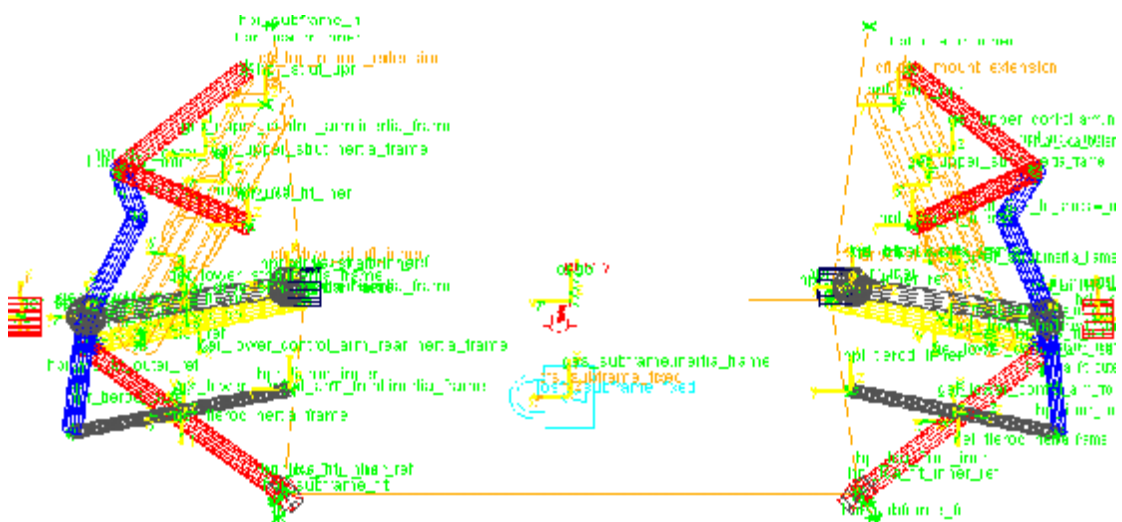
点击 Build 下拉菜单，选择 Attachments>Joint>New。



在出现的对话框里输入以下内容：

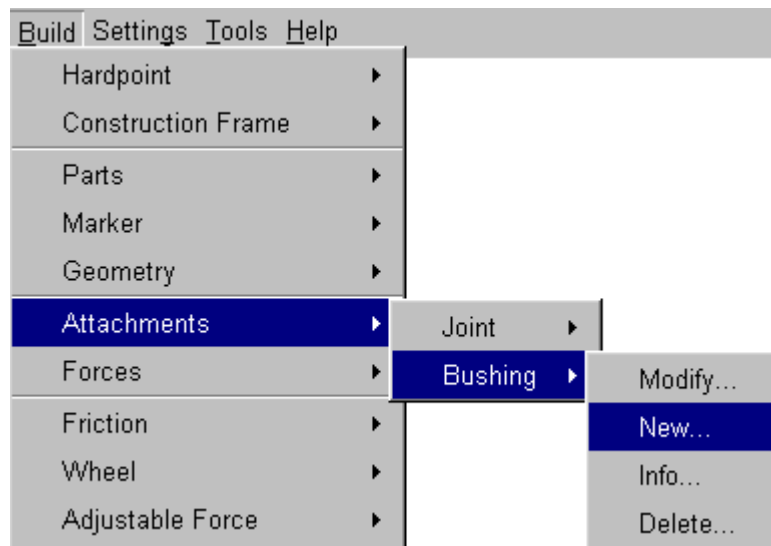


点击 OK。如下图所示，固定连接是一个锁状的符号。



### 2.12.2 创建控制臂衬套






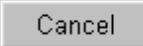
点击 Build 下拉菜单，选择 Attachments>Bushing>New



在出现的对话框里输入以下内容：

**Create Bushing Attachment**




Bushing Name	lca_front
I Part	._BMW_X5_front_suspension_model.gel_lower_control_arm_front
J Part	._BMW_X5_front_suspension_model.ges_subframe
Type	<input checked="" type="radio"/> left <input type="radio"/> right <input type="radio"/> single
Inactive	<input checked="" type="radio"/> never <input type="radio"/> kinematic mode
Preload	0,0,0
Tpreload	0,0,0
Offset	0,0,0
Roffset	0,0,0
Geometry Length	30
Geometry Radius	30
Property File	mdids://adrieline_shared/bushings.tbl/mdi_0001.bus
Location Dependency	Delta location from coordinate
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_lca_front_iner
Location	0,0,0
Location in	<input checked="" type="radio"/> local <input type="radio"/> global
Orientation Dependency	Orient axis to point
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_lca_ftt_inner_ref
Axis	<input checked="" type="radio"/> Z <input type="radio"/> X

点击 Apply，完成下前控制臂内点衬套创建，在当前对话框里输入以下内容：




**Create Bushing Attachment**

Bushing Name	lca_rear_inner
I Part	._BMW_X5_front_suspension_model.gel_lower_control_arm_rear
J Part	._BMW_X5_front_suspension_model.ges_subframe
Type	<input checked="" type="radio"/> left <input type="radio"/> right <input type="radio"/> single
Inactive	<input checked="" type="radio"/> never <input type="radio"/> kinematic mode
Preload	0,0,0
Tpreload	0,0,0
Offset	0,0,0
Roffset	0,0,0
Geometry Length	30
Geometry Radius	30
Property File	mdids://adriveline_shared/bushings.tbl/mdj_0001.bus
Location Dependency	Delta location from coordinate
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_lca_rr_iner
Location	0,0,0
Location in	<input checked="" type="radio"/> local <input type="radio"/> global
Orientation Dependency	Orient axis to point
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_lca_rr_inner_ref
Axis	<input checked="" type="radio"/> Z <input type="radio"/> X




OK Apply Cancel

点击 Apply，完成下后前控制臂内点衬套创建，在当前对话框里输入以下内容：

Create Bushing Attachment	
Bushing Name	uca_inner_front
I Part	._BMW_X5_front_suspension_model.gel_upper_control_arm
J Part	._BMW_X5_front_suspension_model.mtl_uca_to_body
Type	<input checked="" type="radio"/> left <input type="radio"/> right <input type="radio"/> single
Inactive	<input checked="" type="radio"/> never <input type="radio"/> kinematic mode
Preload	0,0,0
Tpreload	0,0,0
Offset	0,0,0
Roffset	0,0,0
Geometry Length	30
Geometry Radius	30
Property File	mdids://adveline_shared/bushings.tbl/mdi_0001.bus
Location Dependency	Delta location from coordinate
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_uca_frt_iner
Location	0,0,0
Location in	<input checked="" type="radio"/> local <input type="radio"/> global
Orientation Dependency	Orient axis to point
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_uca_rr_inner
Axis	<input checked="" type="radio"/> Z <input type="radio"/> X

OK




Apply

Cancel




点击 Apply，完成上控制臂内前点衬套创建，在当前对话框里输入以下内容：

**Create Bushing Attachment**

Bushing Name	uca inner rear
I Part	._BMW_X5_front_suspension_model.gel_upper_control_arm
J Part	._BMW_X5_front_suspension_model.mtl_uca_to_body
Type	<input checked="" type="radio"/> left <input type="radio"/> right <input type="radio"/> single
Inactive	<input checked="" type="radio"/> never <input type="radio"/> kinematic mode
Preload	0,0,0
Tpreload	0,0,0
Offset	0,0,0
Roffset	0,0,0
Geometry Length	30
Geometry Radius	30
Property File	mdids://adriveline_shared/bushings.tbl/mdi_0001.bus
Location Dependency	Delta location from coordinate
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_uca_rr_inner
Location	0,0,0
Location in	<input checked="" type="radio"/> local <input type="radio"/> global
Orientation Dependency	Orient axis to point
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_uca_frt_iner
Axis	<input checked="" type="radio"/> Z <input type="radio"/> X








点击 Apply，完成上控制臂内后点衬套创建，在当前对话框里输入以下内容：

Create Bushing Attachment	
Bushing Name	subframe_front
I Part	._BMW_X5_front_suspension_model.ges_subframe
J Part	._BMW_X5_front_suspension_model.mtl_uca_to_body
Type	<input checked="" type="radio"/> left <input type="radio"/> right <input type="radio"/> single
Inactive	<input checked="" type="radio"/> never <input type="radio"/> kinematic mode
Preload	0,0,0
Tpreload	0,0,0
Offset	0,0,0
Roffset	0,0,0
Geometry Length	30
Geometry Radius	30
Property File	mdids://adriveline_shared/bushings.tbl/mdi_0001.bus
Location Dependency	Delta location from coordinate
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_subframe_frt
Location	0,0,0
Location in	<input checked="" type="radio"/> local <input type="radio"/> global
Orientation Dependency	User entered values
Orient using	<input checked="" type="radio"/> Euler Angles <input type="radio"/> Direction Vectors
Euler Angles	0,0,0
X Vector	1,0,0,0,0
Z Vector	0,0,0,1,0
   <div> <div>OK</div> <div>Apply</div> <div>Cancel</div> </div>	

点击 Apply，完成副车架前点衬套创建，在当前对话框里输入以下内容：

Create Bushing Attachment	
Bushing Name	subframe_rear
I Part	._BMW_X5_front_suspension_model.ges_subframe
J Part	._BMW_X5_front_suspension_model.mtl_uca_to_body
Type	<input checked="" type="radio"/> left <input type="radio"/> right <input type="radio"/> single
Inactive	<input checked="" type="radio"/> never <input type="radio"/> kinematic mode
Preload	0,0,0
Tpreload	0,0,0
Offset	0,0,0
Roffset	0,0,0
Geometry Length	30
Geometry Radius	30
Property File	mdids://adriveline_shared/bushings.tbl/mdi_0001.bus
Location Dependency	Delta location from coordinate
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_subframe_rr
Location	0,0,0
Location in	<input checked="" type="radio"/> local <input type="radio"/> global
Orientation Dependency	User entered values
Orient using	<input checked="" type="radio"/> Euler Angles <input type="radio"/> Direction Vectors
Euler Angles	0,0,0
X Vector	1,0,0,0,0
Z Vector	0,0,0,1,0

OK




Apply

Cancel

点击 Apply，完成副车架后点衬套创建，在当前对话框里输入以下内容：

**Create Bushing Attachment**




Bushing Name	strut_lower
I Part	._BMW_X5_front_suspension_model.gel_lower_strut
J Part	._BMW_X5_front_suspension_model.gel_lower_control_arm_rear
Type	<input checked="" type="radio"/> left <input type="radio"/> right <input type="radio"/> single
Inactive	<input checked="" type="radio"/> never <input type="radio"/> kinematic mode
Preload	0,0,0
Tpreload	0,0,0
Offset	0,0,0
Roffset	0,0,0
Geometry Length	30
Geometry Radius	30
Property File	mdids://adriveline_shared/bushings.tbl/mdi_0001.bus
Location Dependency	Delta location from coordinate
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_strut_lwr
Location	0,0,0
Location in	<input checked="" type="radio"/> local <input type="radio"/> global
Orientation Dependency	Orient axis to point
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_strut_lwr_ref
Axis	<input checked="" type="radio"/> Z <input type="radio"/> X




OK Apply Cancel

点击 Apply，完成前滑柱下点衬套创建，在当前对话框里输入以下内容：

**Create Bushing Attachment**

Bushing Name	strut_upr
I Part	._BMW_X5_front_suspension_model.gel_upper_strut
J Part	._BMW_X5_front_suspension_model.mtl_strut_to_body
Type	<input checked="" type="radio"/> left <input type="radio"/> right <input type="radio"/> single
Inactive	<input checked="" type="radio"/> never <input type="radio"/> kinematic mode
Preload	0,0,0
Tpreload	0,0,0
Offset	0,0,0
Roffset	0,0,0
Geometry Length	30
Geometry Radius	30
Property File	mdids://adrieline_shared/bushings.tbl/mdi_0001.bus
Location Dependency	Delta location from coordinate
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_strut_upr
Location	0,0,0
Location in	<input checked="" type="radio"/> local <input type="radio"/> global
Orientation Dependency	Orient axis to point
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_strut_lwr
Axis	<input checked="" type="radio"/> Z <input type="radio"/> X

OK Apply Cancel

点击 Apply，完成前滑柱上点衬套创建，在当前对话框里输入以下内容：

**Create Joint Attachment**

Joint Name:

I Part:

J Part:

Type: ☒ left ☐ right ☐ single

Joint Type:

Active: ☒ always ☐ kinematic mode

Location Dependency:



Coordinate Reference:

Location:

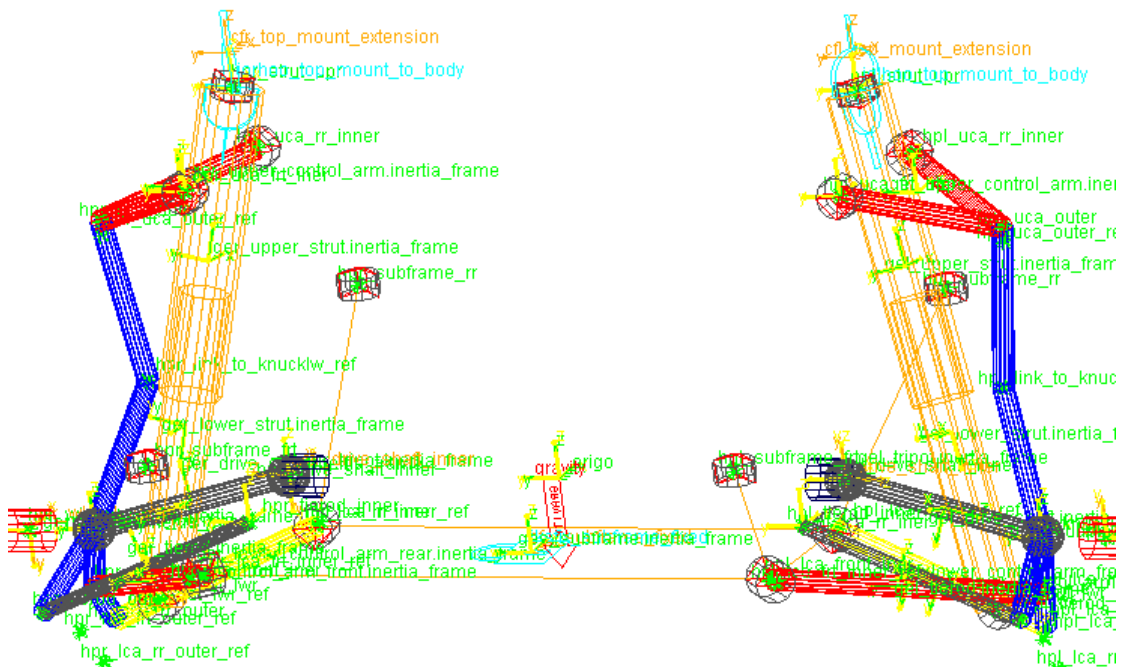
Location in: ☒ local ☐ global

I-Part Axis:

J-Part Axis:

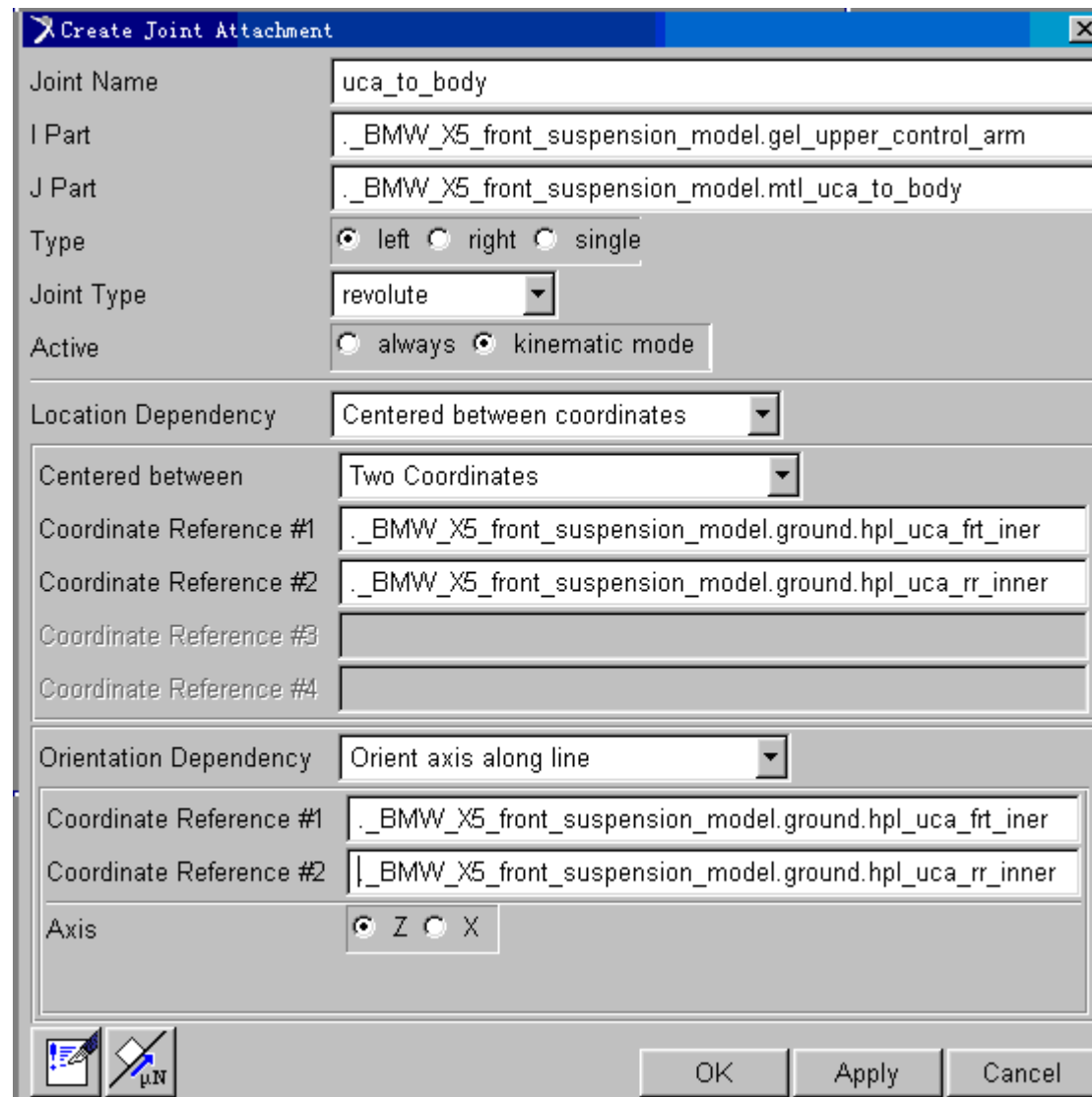
点击 OK，至此悬架所有的衬套已经完成创建，如下图所示：



### 2.12.3 创建 part 之间的刚性连接

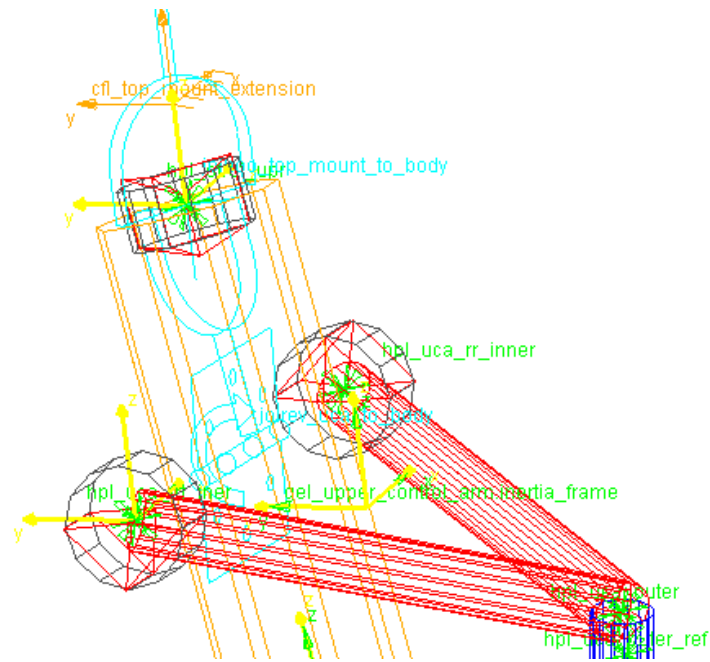
#### 1) 上控制臂与车身之间的旋转铰

前面已经在上控制臂与车身之间创建了衬套,但是有时为了作运动学分析需要部件之间建立刚性连接。BMW X5 上控制臂与车身铰接的前后两衬套轴线同轴,故可以用一个旋转铰完成。按照前面的方法,创建如下的旋转铰:



其中 Active 一栏选择 kinematic mode,表明该旋转铰仅在运动学模式下激活,在其它模式下不起作用。点击 Apply。

#### 2) 创建前滑柱与车身间的万向节



### 3) 建立滑柱下旋转铰

Create Joint Attachment

Joint Name

strut\_lwr

I Part

.\_BMW\_X5\_front\_suspension\_model.gel\_lower\_strut

J Part

.\_BMW\_X5\_front\_suspension\_model.gel\_lower\_control\_arm\_rear

Type

☒ left
 ☐ right
 ☐ single

Joint Type

revolute

Active

☐ always
 ☒ kinematic mode

Location Dependency

Delta location from coordinate

Coordinate Reference

.\_BMW\_X5\_front\_suspension\_model.ground.hpl\_strut\_lwr

Location

0,0,0

Location in

☒ local
 ☐ global

Orientation Dependency

Orient axis to point

Coordinate Reference

.\_BMW\_X5\_front\_suspension\_model.ground.hpl\_strut\_lwr\_ref

Axis

☒ Z
 ☐ X

OK

Apply

Cancel

其中 Active 一栏同样选择 kinematic mode，点击 Apply。

4) 创建减振器活塞与缸筒之间的圆柱铰

在当前的对话框里输入以下内容：

Joint Name: upr\_to\_lwr\_strut

I Part: .BMW\_X5\_front\_suspension\_model.gel\_upper\_strut

J Part: .BMW\_X5\_front\_suspension\_model.gel\_lower\_strut

Type: ☒ left ☐ right ☐ single

Joint Type: cylindrical

Active: ☒ always ☐ kinematic mode

Location Dependency: Centered between coordinates

Centered between: Two Coordinates

Coordinate Reference #1: .BMW\_X5\_front\_suspension\_model.ground.hpl\_strut\_upr

Coordinate Reference #2: .BMW\_X5\_front\_suspension\_model.ground.hpl\_strut\_lwr

Coordinate Reference #3:

Coordinate Reference #4:

Orientation Dependency: Orient axis along line

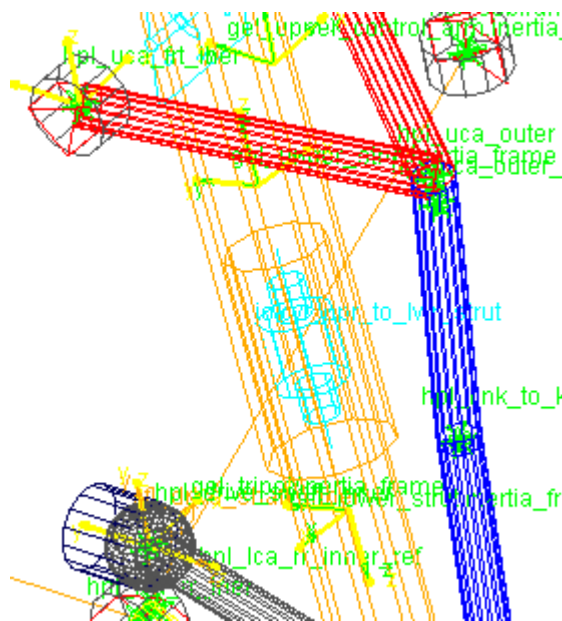
Coordinate Reference #1: .BMW\_X5\_front\_suspension\_model.ground.hpl\_strut\_upr

Coordinate Reference #2: .BMW\_X5\_front\_suspension\_model.ground.hpl\_strut\_lwr



Axis: ☒ Z ☐ X ☐ Y

Buttons: OK, Apply, Cancel

其中 Active 一栏选择 always，表示该圆柱铰永远被激活。点击 Apply，如下图所示：



##### 5) 创建下前控制臂外端球铰

Create Joint Attachment	
Joint Name	lca_fit_outer
I Part	._BMW_X5_front_suspension_model.gel_lower_control_arm_front
J Part	._BMW_X5_front_suspension_model.gel_knuckle
Type	<input checked="" type="radio"/> left <input type="radio"/> right <input type="radio"/> single
Joint Type	spherical
Active	<input checked="" type="radio"/> always <input type="radio"/> kinematic mode
Location Dependency	Delta location from coordinate
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_lca_fit_outer
Location	0,0,0
Location in	<input checked="" type="radio"/> local <input type="radio"/> global
Orientation	Using Two Axes
I-Part Axis	._BMW_X5_front_suspension_model.ground.hpl_lca_front_iner
J-Part Axis	._BMW_X5_front_suspension_model.ground.hpl_lca_fit_outer_ref
<div>   </div> <div> <div>OK</div> <div>Apply</div> <div>Cancel</div> </div>	

其中 Active 一栏同样选择 always，点击 Apply

##### 6) 创建下后控制臂外端球铰

**Create Joint Attachment**

Joint Name: lca\_rr\_outer

I Part: .\_BMW\_X5\_front\_suspension\_model.gel\_lower\_control\_arm\_rear

J Part: .\_BMW\_X5\_front\_suspension\_model.gel\_knuckle

Type: ☒ left ☐ right ☐ single

Joint Type: spherical

Active: ☒ always ☐ kinematic mode

Location Dependency: Delta location from coordinate

Coordinate Reference: .\_BMW\_X5\_front\_suspension\_model.ground.hpl\_lca\_rr\_outer

Location: 0,0,0

Location in: ☒ local ☐ global

Orientation: Using Two Axes

I-Part Axis: .\_BMW\_X5\_front\_suspension\_model.ground.hpl\_lca\_rr\_iner

J-Part Axis: .\_BMW\_X5\_front\_suspension\_model.ground.hpl\_lca\_rr\_outer\_ref

OK Apply Cancel

其中 Active 一栏同样选择 always，点击 Apply。

#### 7) 创建转向横拉杆与转向节处的球铰

在当前的 Create Joint Attachment 对话框里输入以下内容：

**Create Joint Attachment**

Joint Name: tierod\_outer

I Part: .\_BMW\_X5\_front\_suspension\_model.gel\_lower\_control\_arm\_front\_inertia\_frame

J Part: .\_BMW\_X5\_front\_suspension\_model.gel\_knuckle

Type: ☒ left ☐ right ☐ single

Joint Type: spherical

Active: ☒ always ☐ kinematic mode

Location Dependency: Delta location from coordinate

Coordinate Reference: .\_BMW\_X5\_front\_suspension\_model.ground.hpl\_tierod\_outer

Location: 0,0,0

Location in: ☒ local ☐ global

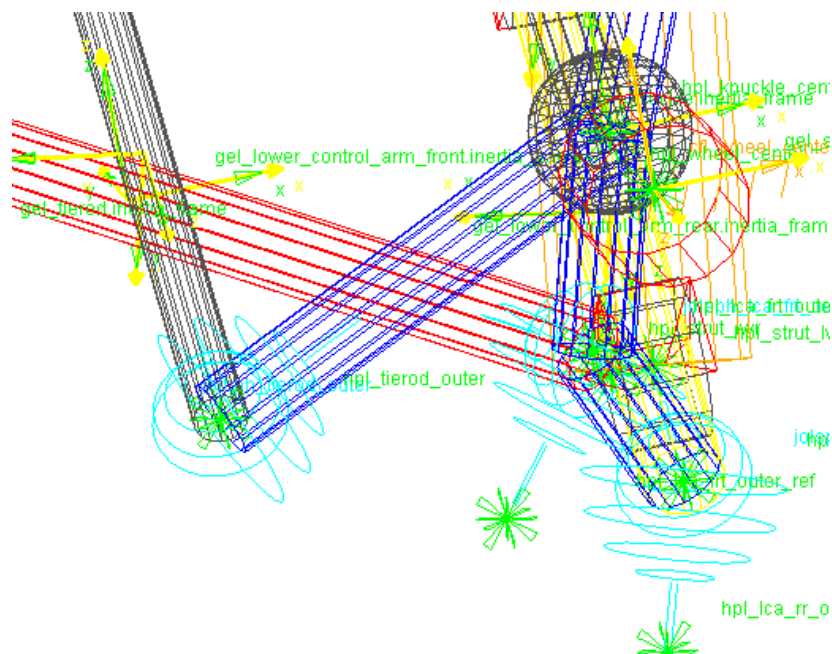
Orientation: Using Two Axes

I-Part Axis: .\_BMW\_X5\_front\_suspension\_model.ground.hpl\_tierod\_inner

J-Part Axis: .\_BMW\_X5\_front\_suspension\_model.ground.hpl\_knuckle\_center

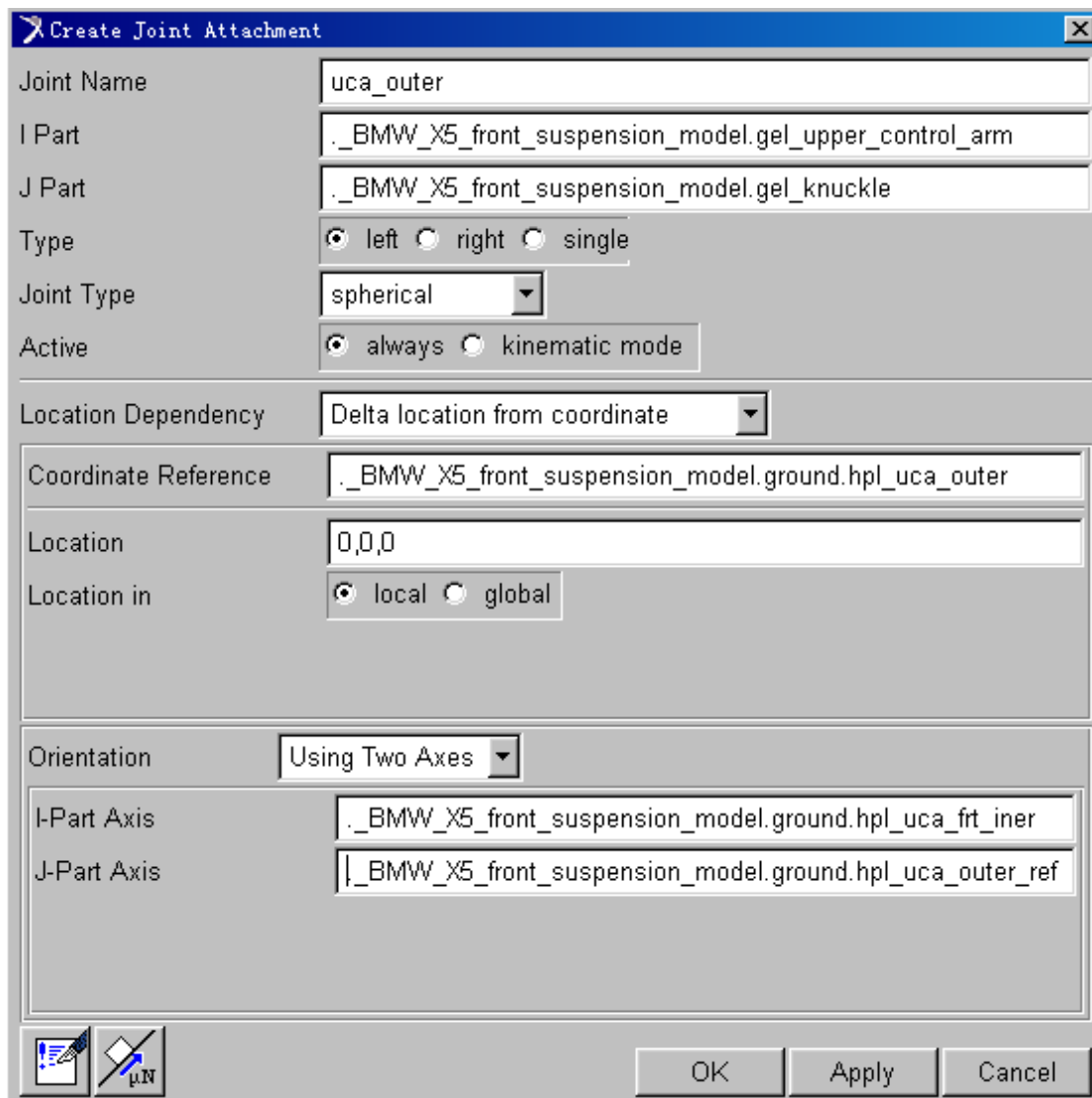
OK Apply Cancel

其中 Active 一栏同样选择 always，点击 Apply，如下图所示：

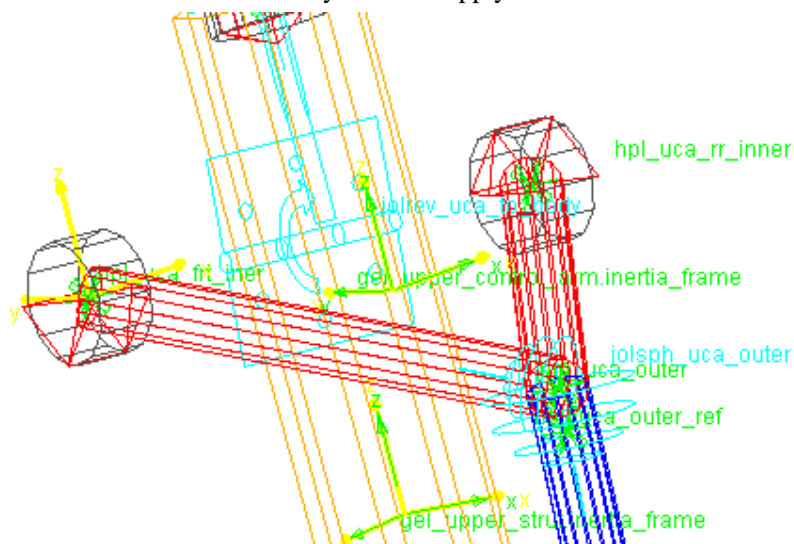


#### 8) 创建上控制臂外点球铰

在当前的 Create Joint Attachment 对话框里输入以下内容:

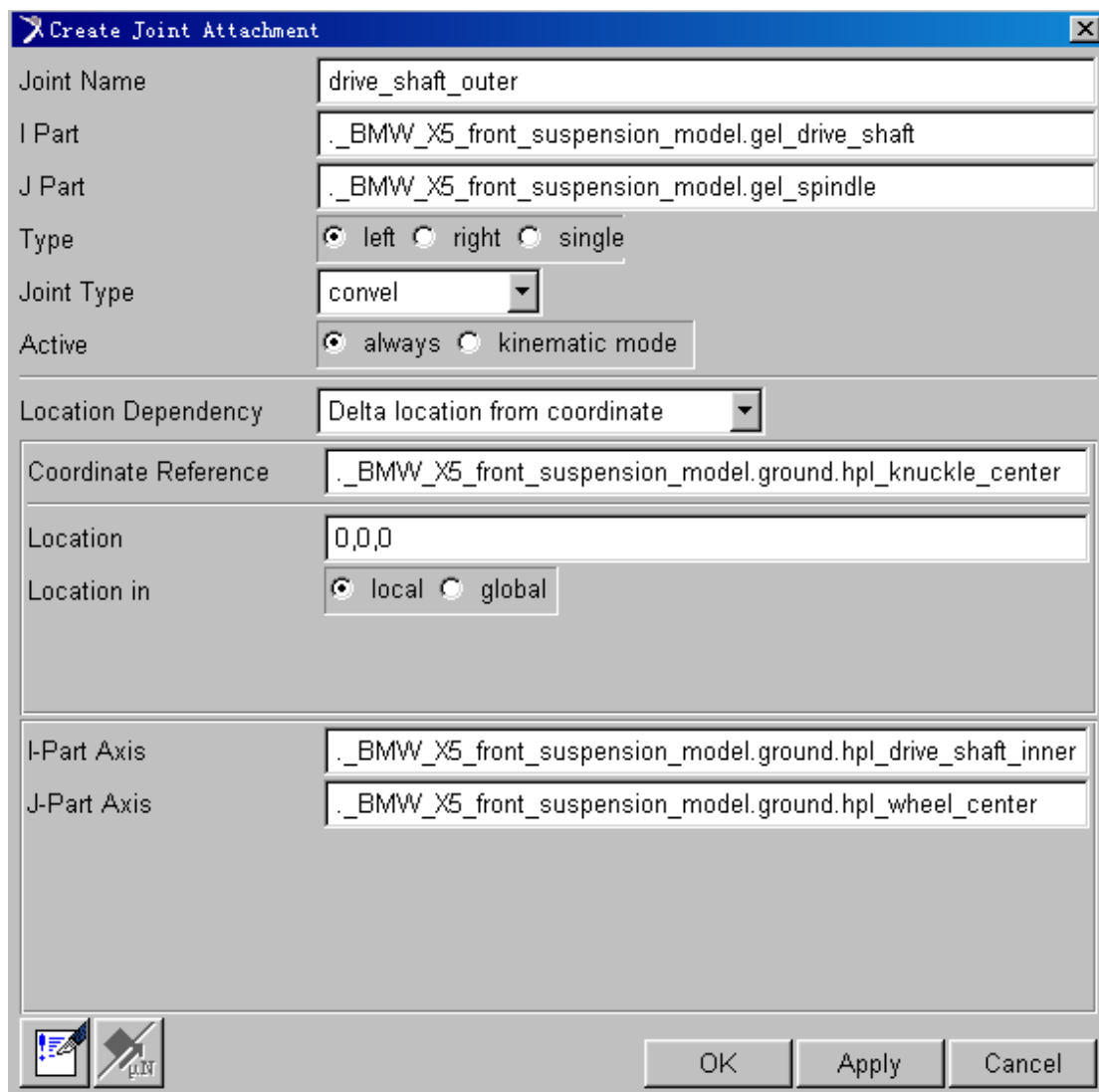


其中 Active 一栏同样选择 always, 点击 Apply, 如下图所示:



#### 9) 创建传动轴外点和内点处等速万向节

在当前的 Create Joint Attachment 对话框里输入以下内容：



Joint Name: drive\_shaft\_outer

I Part: .BMW\_X5\_front\_suspension\_model.gel\_drive\_shaft

J Part: .BMW\_X5\_front\_suspension\_model.gel\_spindle

Type: ☒ left ☐ right ☐ single

Joint Type: convel

Active: ☒ always ☐ kinematic mode

Location Dependency: Delta location from coordinate

Coordinate Reference: .BMW\_X5\_front\_suspension\_model.ground.hpl\_knuckle\_center

Location: 0,0,0

Location in: ☒ local ☐ global

I-Part Axis: .BMW\_X5\_front\_suspension\_model.ground.hpl\_drive\_shaft\_inner



J-Part Axis: .BMW\_X5\_front\_suspension\_model.ground.hpl\_wheel\_center

Buttons: OK, Apply, Cancel

其中 Active 一栏同样选择 always，点击 Apply，类似输入以下内容：

**Create Joint Attachment**

Joint Name	drive_shaft_inner
I Part	._BMW_X5_front_suspension_model.gel_drive_shaft
J Part	._BMW_X5_front_suspension_model.gel_tripot
Type	<input checked="" type="radio"/> left <input type="radio"/> right <input type="radio"/> single
Joint Type	convel
Active	<input checked="" type="radio"/> always <input type="radio"/> kinematic mode
Location Dependency	Delta location from coordinate
Coordinate Reference	._BMW_X5_front_suspension_model.ground.hpl_drive_shaft_inner
Location	0,0,0
Location in	<input checked="" type="radio"/> local <input type="radio"/> global
I-Part Axis	._BMW_X5_front_suspension_model.ground.hpl_knuckle_center
J-Part Axis	._BMW_X5_front_suspension_model.ground.hpr_drive_shaft_inner

OK Apply Cancel

点击 Apply。

- 10) 创建传动轴内点的滑动铰  
在当前的对话框里输入以下内容：

**Create Joint Attachment**

Joint Name: tripot\_to\_differential

I Part: .\_BMW\_X5\_front\_suspension\_model.gel\_tripot

J Part: .\_BMW\_X5\_front\_suspension\_model.mtl\_tripot\_to\_differential

Type: ☒ left ☐ right ☐ single

Joint Type: translational

Active: ☒ always ☐ kinematic mode

Location Dependency: Delta location from coordinate

Coordinate Reference: .\_BMW\_X5\_front\_suspension\_model.ground.hpl\_drive\_shaft\_inner

Location: 0,0,0

Location in: ☒ local ☐ global

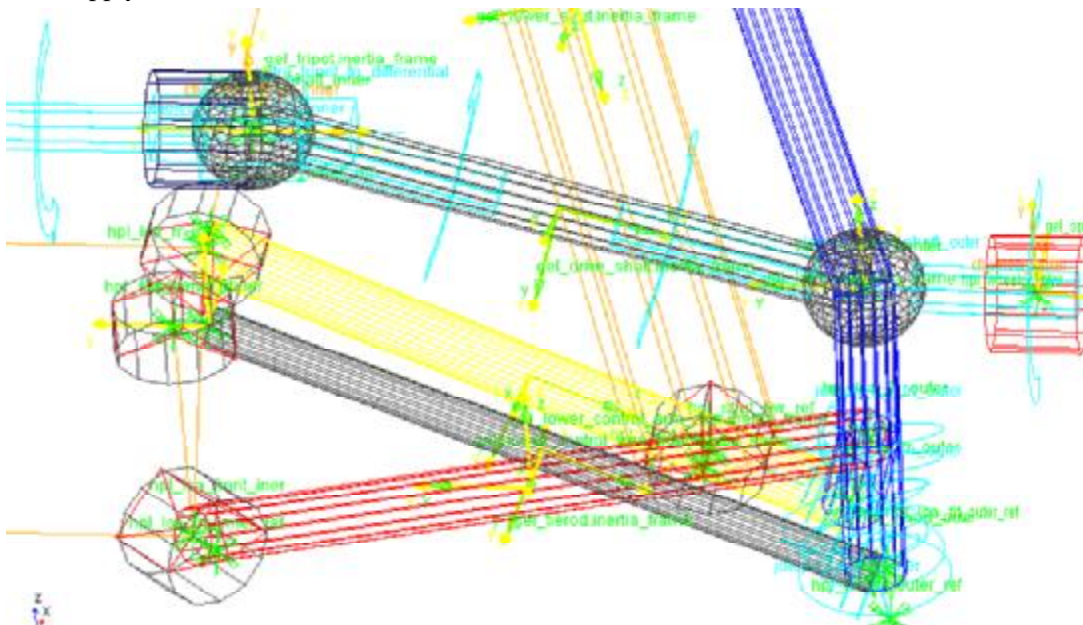
Orientation Dependency: Orient axis to point

Coordinate Reference: .\_BMW\_X5\_front\_suspension\_model.ground.hpr\_drive\_shaft\_inne

Axis: ☒ Z ☐ X

OK Apply Cancel

点击 Apply，建立的连接如下图所示：



11) 创建转向横拉杆内点等速万向节

在当前的对话框里输入以下内容：

**Create Joint Attachment**

Joint Name: tierod\_inner

I Part: . \_BMW\_X5\_front\_suspension\_model.gel\_tierod

J Part: . \_BMW\_X5\_front\_suspension\_model.mtl\_tierod\_to\_steering

Type: ☒ left ☐ right ☐ single

Joint Type: convel

Active: ☒ always ☐ kinematic mode

Location Dependency: Delta location from coordinate

Coordinate Reference: . \_BMW\_X5\_front\_suspension\_model.ground.hpl\_tierod\_inner

Location: 0,0,0

Location in: ☒ local ☐ global

I-Part Axis: . \_BMW\_X5\_front\_suspension\_model.ground.hpl\_tierod\_outer

J-Part Axis: . \_BMW\_X5\_front\_suspension\_model.ground.hpr\_tierod\_inner

OK Apply Cancel

点击 Apply。

12) 创建车轮与转向节之间的旋转铰

在当前的对话框里输入以下内容：

Create Joint Attachment

Joint Name

spindle\_to\_knuckle

I Part

.\_BMW\_X5\_front\_suspension\_model.gel\_spindle

J Part

.\_BMW\_X5\_front\_suspension\_model.gel\_knuckle

Type

☒ left
☐ right
☐ single

Joint Type

revolute

Active

☒ always
☐ kinematic mode

Location Dependency

Delta location from coordinate

Coordinate Reference

.\_BMW\_X5\_front\_suspension\_model.ground.hpl\_wheel\_center

Location

0,0,0

Location in

☒ local
☐ global

Orientation Dependency

Toe/Camber

Variable Type

Parameter Variables

Toe Parameter Variable

.\_BMW\_X5\_front\_suspension\_model.pvl\_toe\_angle

Camber Parameter Variable

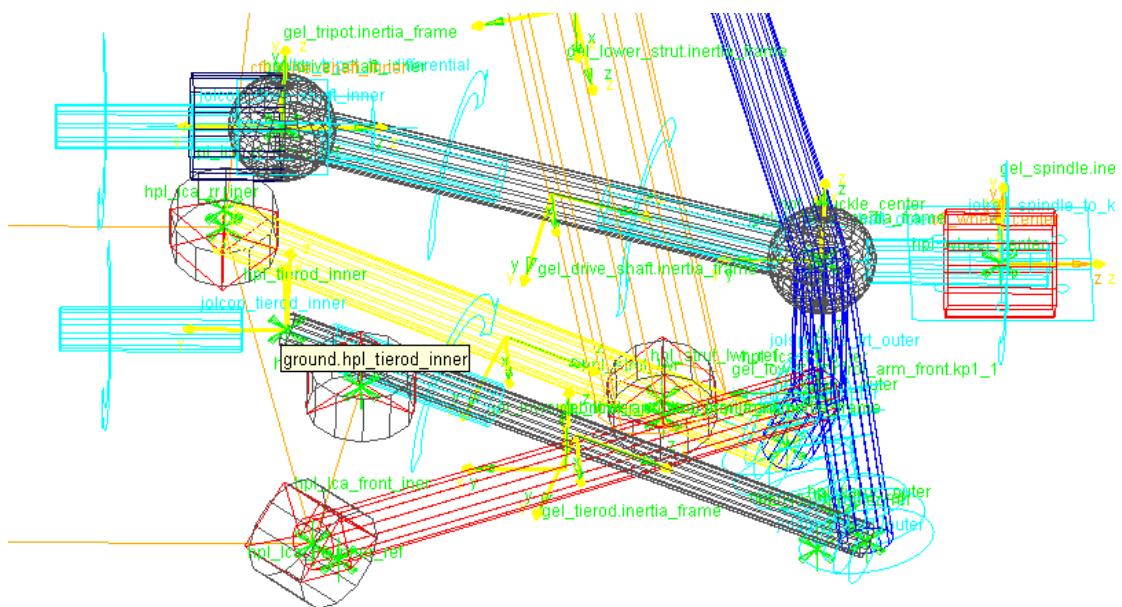
.\_BMW\_X5\_front\_suspension\_model.pvl\_camber\_angle

OK

Apply

Cancel

点击 OK。至此创建的全部连接如下图所示：

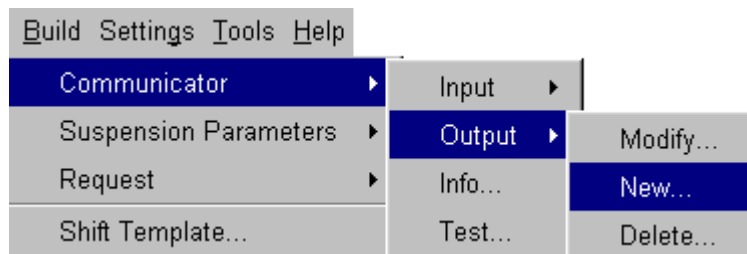


## 2.13 创建通讯器

在前悬架模板里需要自己建立的通讯器如下图所示。

```
col_wheel_center  
cos_rack_housing_to_suspension_subframe  
col_arb_bushing_mount  
col_droplink_to_suspension  
col_toe_angle  
col_camber_angle  
col_suspension_upright  
col_tripot_to_differential  
cos_driveline_active  
col_suspension_mount  
cos_engine_to_subframe  
cos_suspension_parameters_ARRAY
```

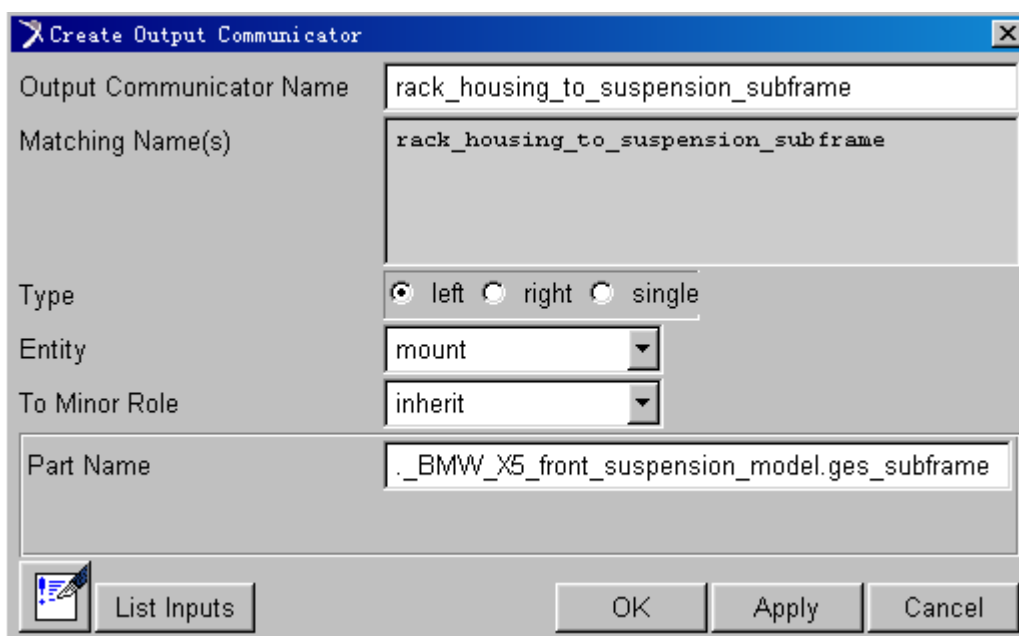
点击 Build 下拉菜单，选择 Communicator>Output>New。



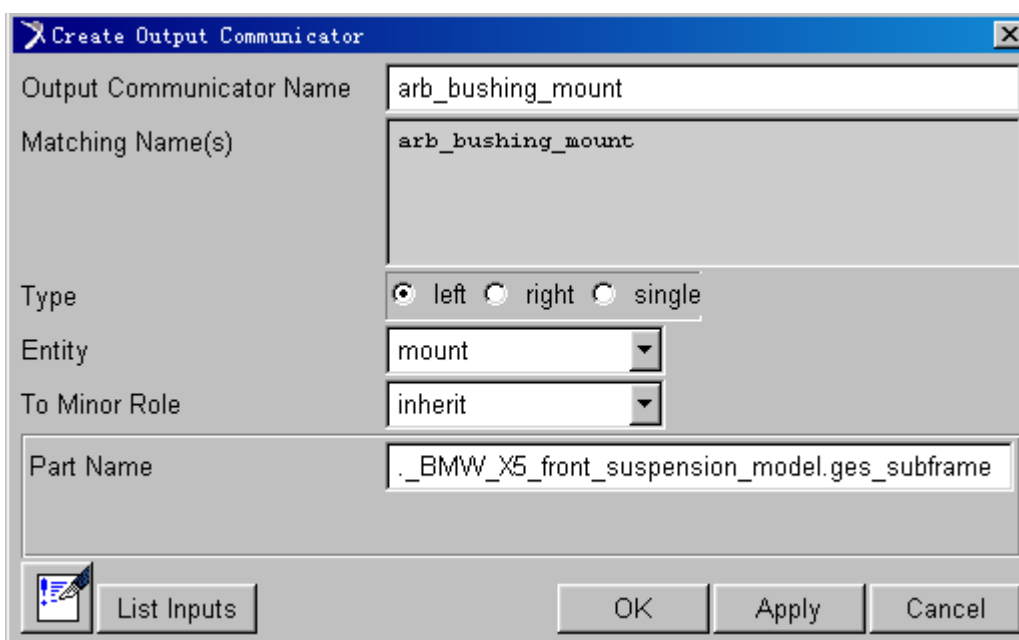
在出现的对话框里输入如下内容：

A screenshot of the 'Create Output Communicator' dialog box. The 'Output Communicator Name' field contains 'wheel\_center'. The 'Matching Name(s)' field contains 'wheel\_center'. The 'Type' section has three radio buttons: 'left' (selected), 'right', and 'single'. The 'Entity' dropdown menu is set to 'location'. The 'To Minor Role' dropdown menu is set to 'inherit'. The 'Coordinate Reference Name' field contains the path '\_BMW\_X5\_front\_suspension\_model.ground.hpl\_wheel\_center'. At the bottom, there are buttons for 'List Inputs' (with a notepad icon), 'OK', 'Apply', and 'Cancel'.

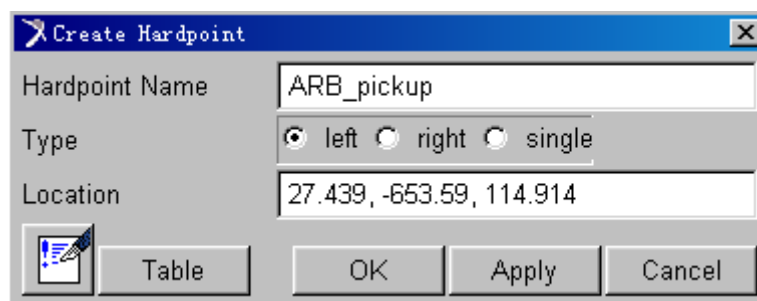
点击 Apply，输入内容如下：



点击 Apply，输入内容如下：



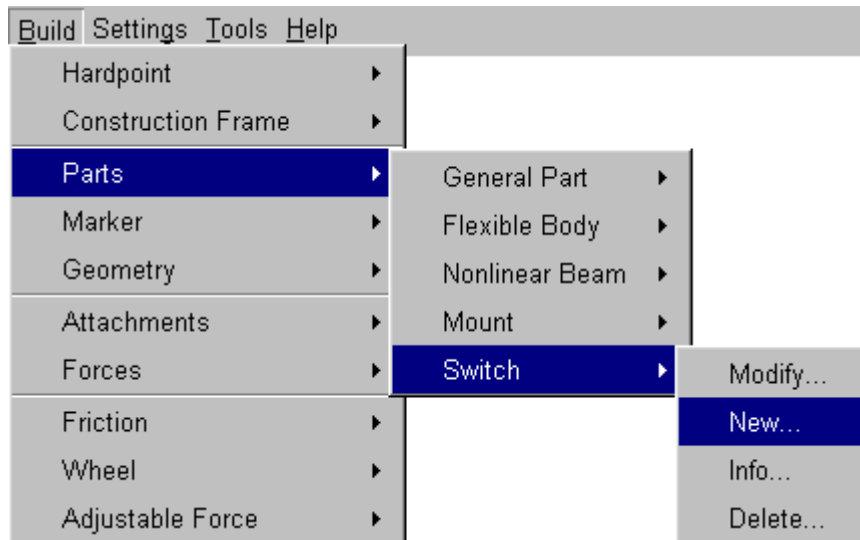
创建稳定杆连接杆上球铰点硬点：



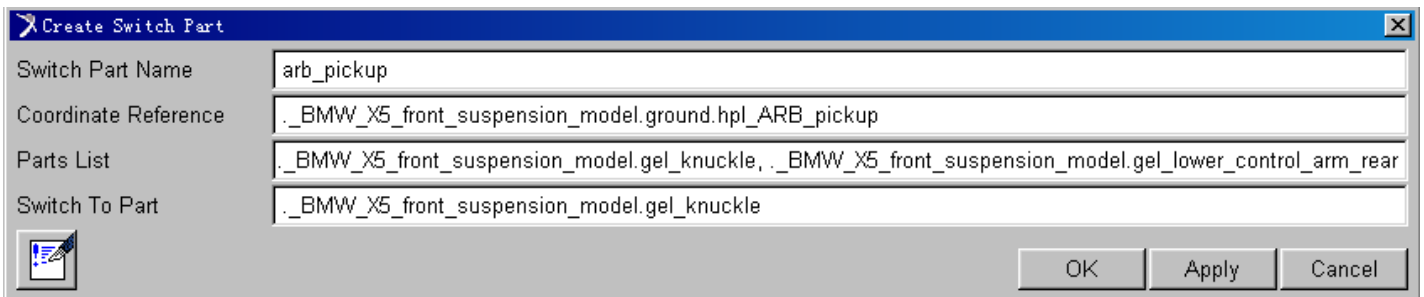
点击 OK。

为便于研究稳定杆连接杆连接对象变化对悬架性能的影响，经常创建一个开关 part

(Switch Part)，顾名思义，它像单刀多掷开关一样，可以很方便的完成连接对象的切换。  
点击 Build 下拉菜单，选择 Parts>Switch>New。

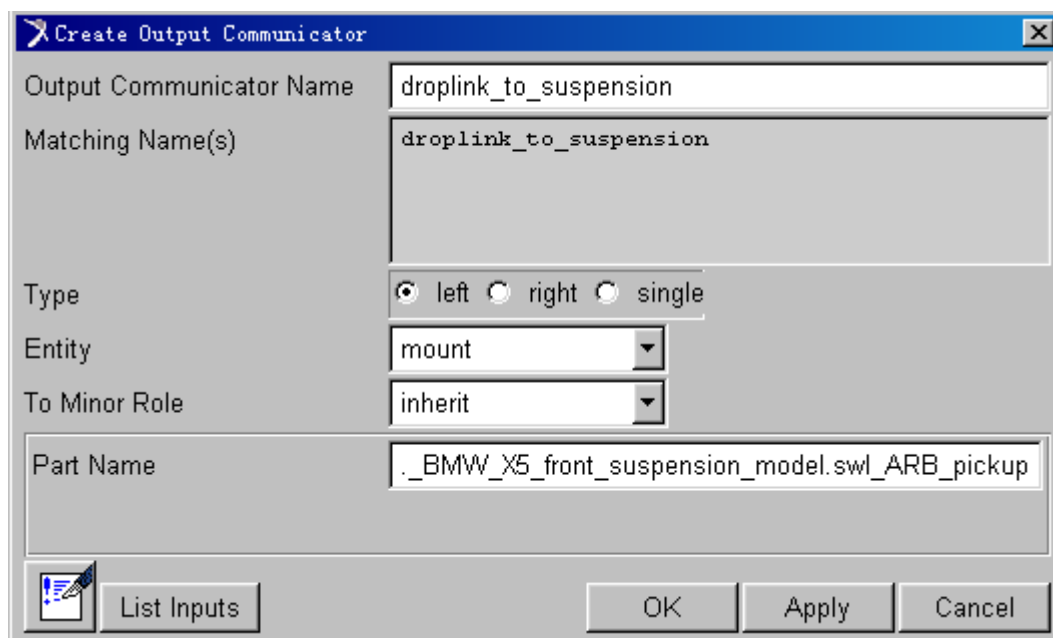


在出现的对话框里输入以下内容：

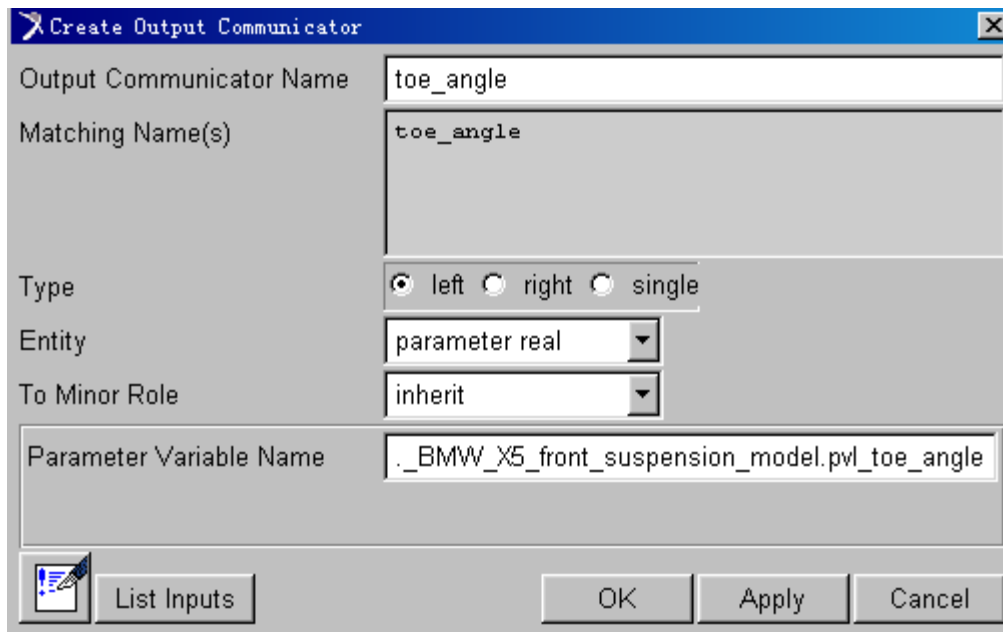


在 Parts List 一栏中右击鼠标，选择 Part>Pick，在屏幕上依次点选 knuckle 和 lower\_control\_arm\_rear，在 Switch To Part 一栏中右击鼠标，选择 Part>Pick，在屏幕上点选 knuckle，点击 OK，完成 Switch Part 的创作。

在 Create Output Communicator 对话框里输入以下内容：



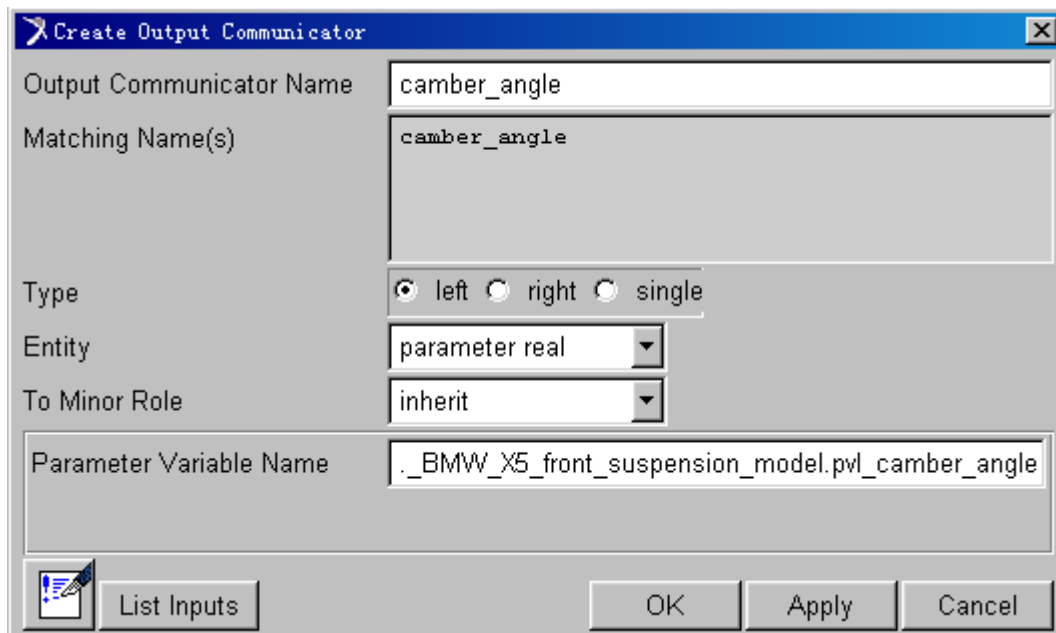
点击 Apply，输入以下内容：



The dialog box is titled "Create Output Communicator". It contains the following fields and controls:

- Output Communicator Name:** toe\_angle
- Matching Name(s):** toe\_angle
- Type:** Radio buttons for left (selected), right, and single.
- Entity:** parameter real
- To Minor Role:** inherit
- Parameter Variable Name:** .\_BMW\_X5\_front\_suspension\_model.pvl\_toe\_angle
- Buttons:** List Inputs (with a notepad icon), OK, Apply, and Cancel.

点击 Apply，输入以下内容：



The dialog box is titled "Create Output Communicator". It contains the following fields and controls:

- Output Communicator Name:** camber\_angle
- Matching Name(s):** camber\_angle
- Type:** Radio buttons for left (selected), right, and single.
- Entity:** parameter real
- To Minor Role:** inherit
- Parameter Variable Name:** .\_BMW\_X5\_front\_suspension\_model.pvl\_camber\_angle
- Buttons:** List Inputs (with a notepad icon), OK, Apply, and Cancel.

点击 Apply，输入以下内容：

**Create Output Communicator**

Output Communicator Name: driveline\_active

Matching Name(s): driveline\_active

Type: ☒ left ☐ right ☐ single

Entity: parameter integer

To Minor Role: inherit

Parameter Variable Name: .\_BMW\_X5\_front\_suspension\_model.pvl\_driveline\_active

List Inputs OK Apply Cancel

点击 Apply，输入以下内容：

**Create Output Communicator**

Output Communicator Name: suspension\_upright

Matching Name(s): suspension\_upright

Type: ☒ left ☐ right ☐ single

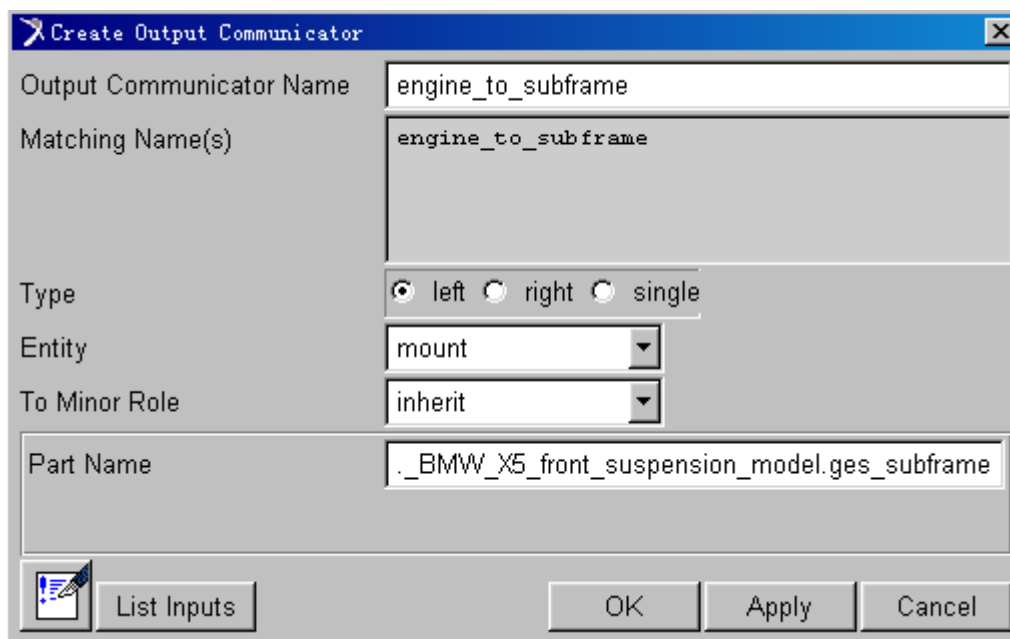
Entity: mount

To Minor Role: inherit

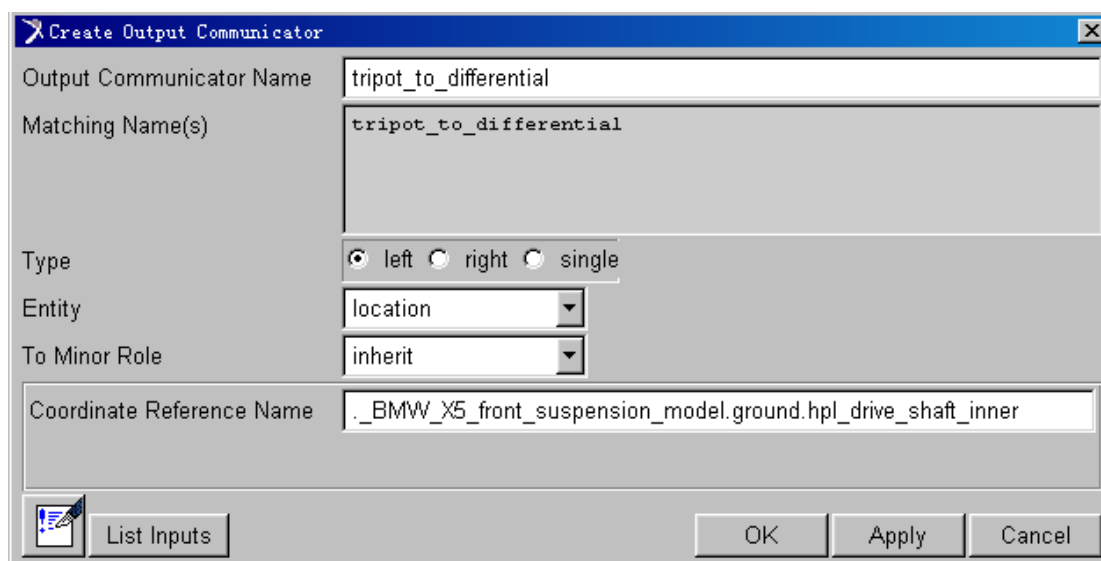
Part Name: .\_BMW\_X5\_front\_suspension\_model.gel\_knuckle

List Inputs OK Apply Cancel

点击 Apply，输入以下内容：



点击 Apply，输入以下内容：

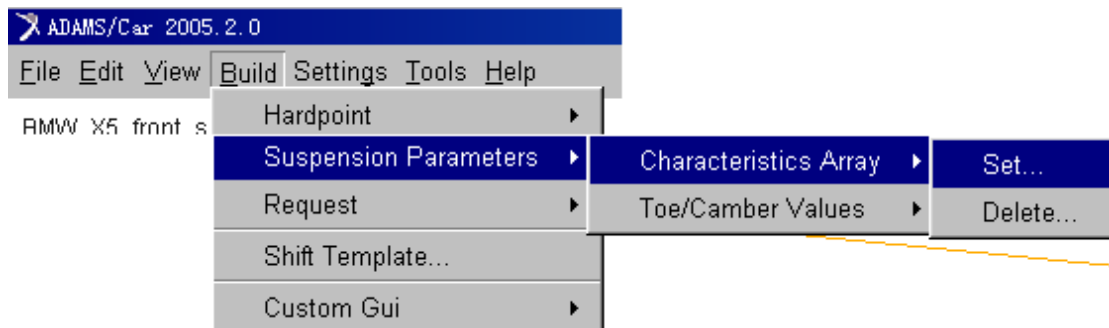


点击 OK。

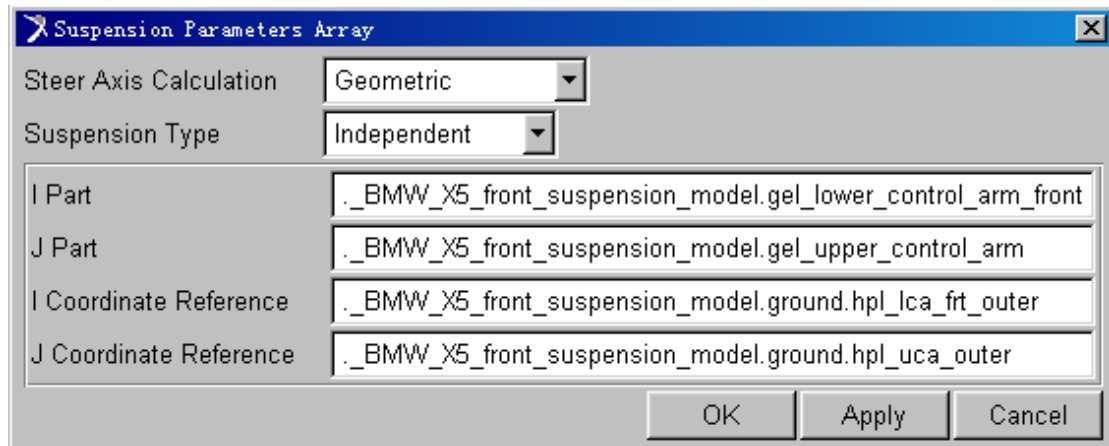
## 2.14 创建悬架参数

### 2.14.1 创建 Characteristics Array

此步是定义悬架主销。方法如下，点击 Build 下拉菜单，选择 Suspension Parameters>Characteristics Array>Set。

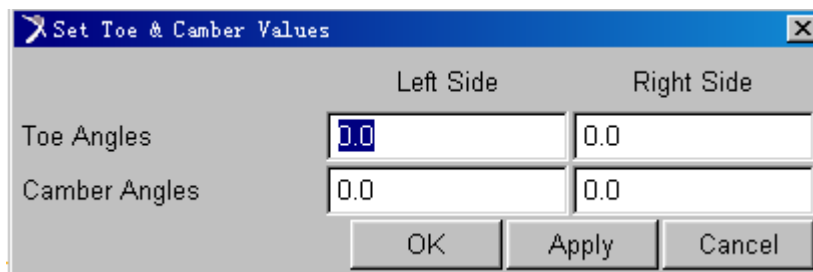


在出现的对话框里输入以下内容：



## 2.14.2 设置 Toe/Camber 数值

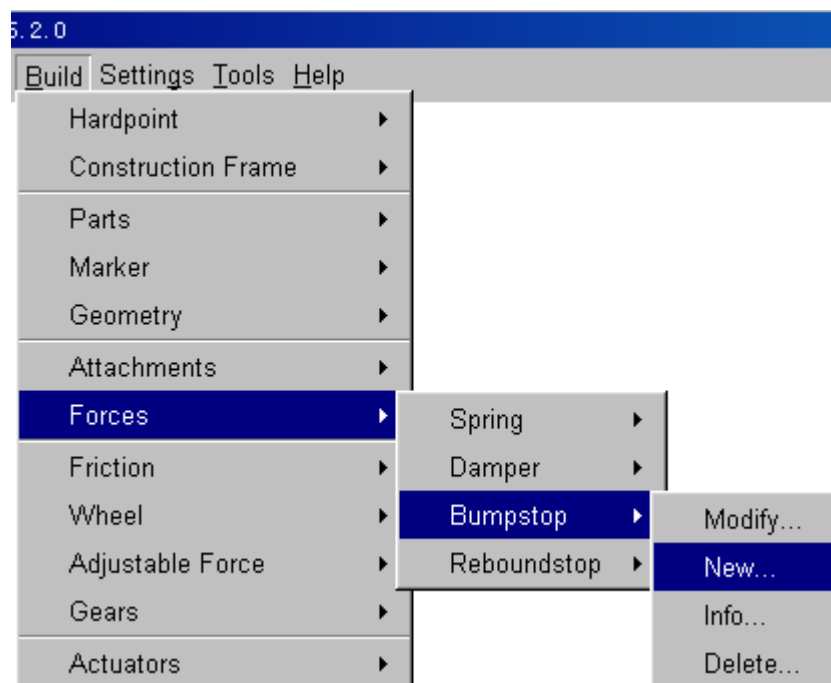
如上图所示，选择 Toe/Camber Values>Set:



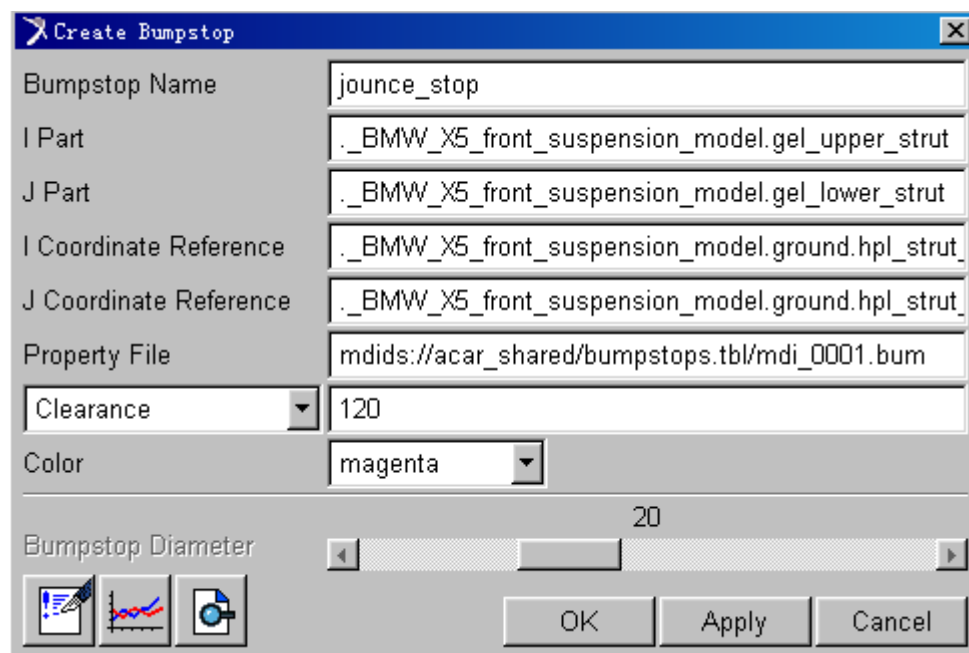
可以在此处输入实际前束和外倾角数值，也可以保留默认的值，在后续子系统中修改。

## 2.15 创建减振器上下行程限位块

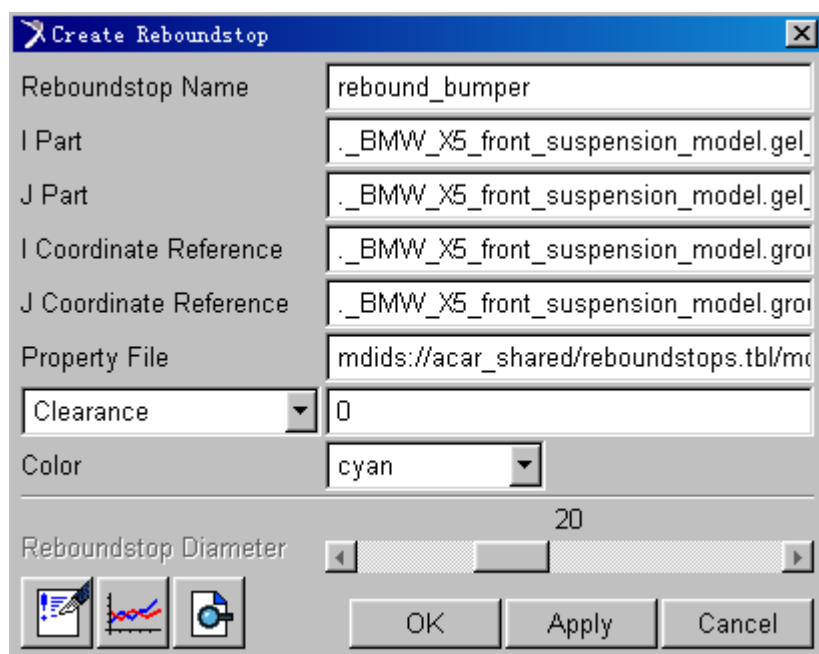
点击 Build 下拉菜单，选择 Forces>Bumstop>New



在出现的对话框里输入以下内容：

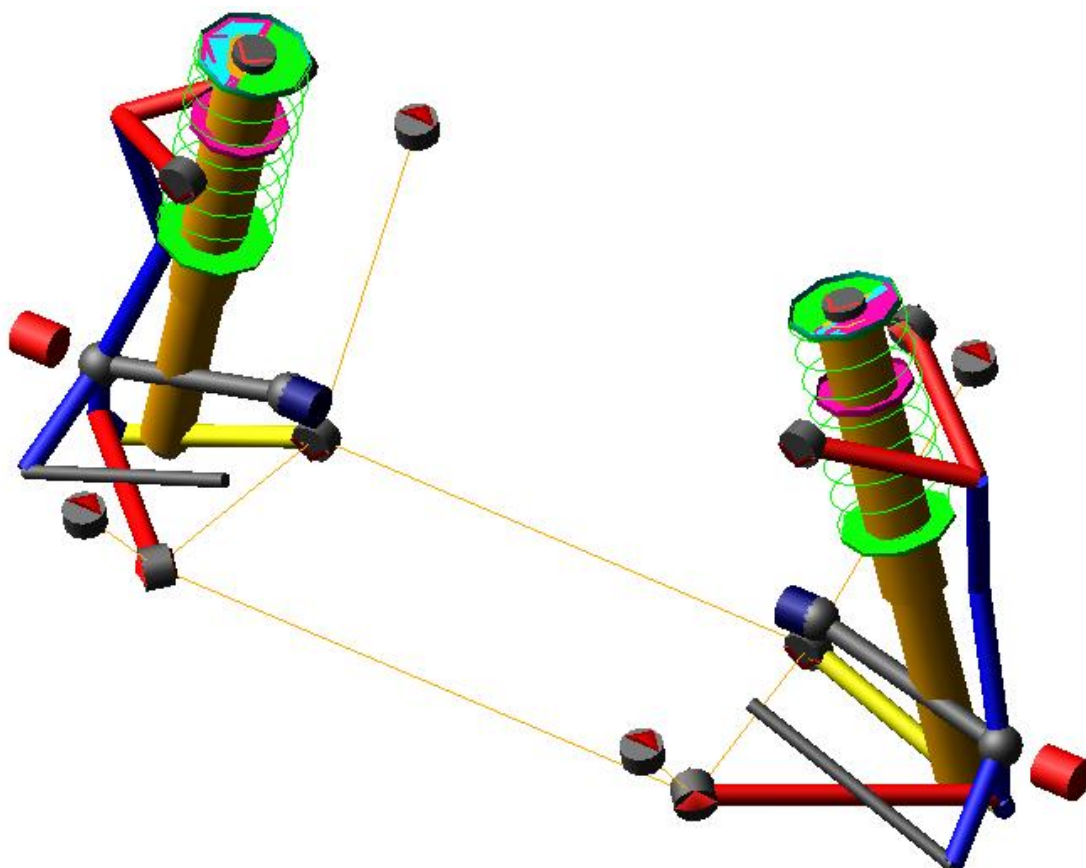


点击 Apply，完成上行程限位块创建，再输入以下内容：



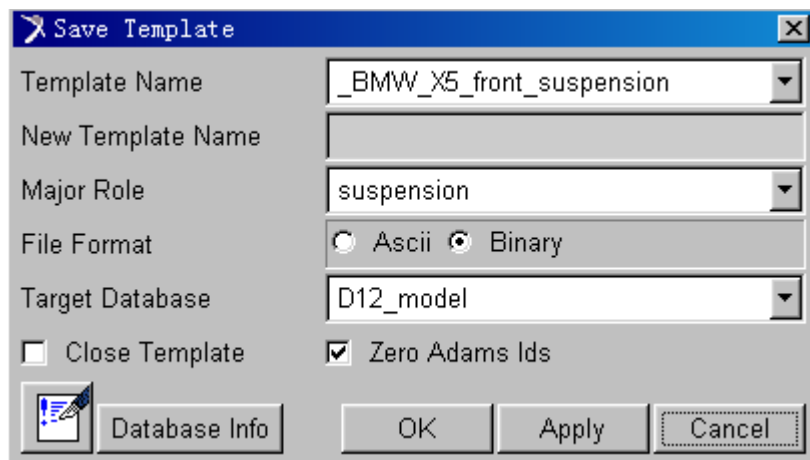
点击 OK，完成下行程限位块的创建。

至此整个前悬架模板已经全部完成，如下图（shade）所示：



## 2.16 保存模型

从下拉菜单选择 File>Save As，在出现的对话框里设定新的模板名称及目标数据库。



点击 OK 完成前悬架模板文件保存。